

Radio Fun

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"The beginner's guide
to the exciting world
of amateur radio."

in this issue

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Malfunction Grounds Earthwinds

A November launch attempt for the Earthwinds around-the-world balloon flight was aborted after a system malfunction damaged the crew capsule. Crewmembers Larry Newman KB7JGM, Richard Abruzzo, and Vladimir Dzhanibekov RV3DD were not on board at the time and no one was injured during the mishap.

Project leaders suspect a cable support anchoring the capsule to the ground gave way, causing the capsule to rise prematurely and then fall. The damage is being assessed. The ham-radio-equipped historic balloon flight has been set back a minimum of six to eight weeks. *TNX W5YI Report, Issue #22, November 15, 1993.*

The Car of the Future

Technology offers new hope for those among us who hate to stop and ask for directions. Commerce Secretary Ron Brown joined automotive industry leaders recently to announce an international agreement which will accelerate the development of practical GPS receivers for motor vehicles.

Many hams are already familiar with the GPS (Global Positioning System) technology. Originally developed by the Department of Defense as a worldwide navigation system for the armed forces, GPS uses satellites to pinpoint the exact locations of special receivers.

Magellan Systems, a California based manufacturer of GPS receivers, will develop, build, and export the units. Experts predict the receivers will be so small and inexpensive they will become a standard feature in new automobiles.

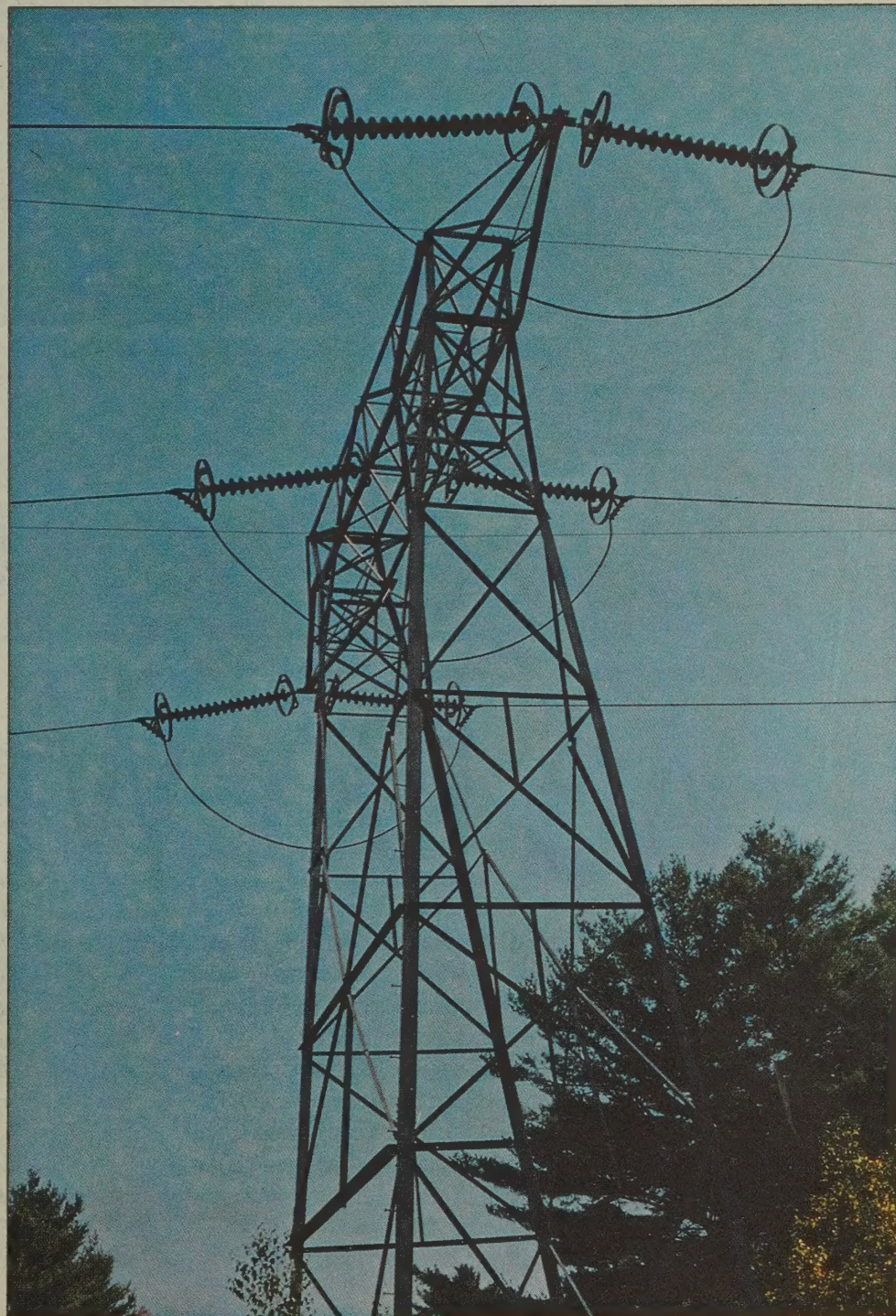
Quick Ticket

The FCC has proposed a measure which would grant temporary operating authority to unlicensed persons who have passed their examinations for new amateur radio licenses. The temporary operating authority would begin when the exam is passed and the application filed. The maximum limit would be 120 days.

The temporary authority would not benefit anyone whose license has been suspended, revoked, or subjected to other FCC enforcement proceedings. The commission reserves the right to yank this operating authority at any time without a hearing.

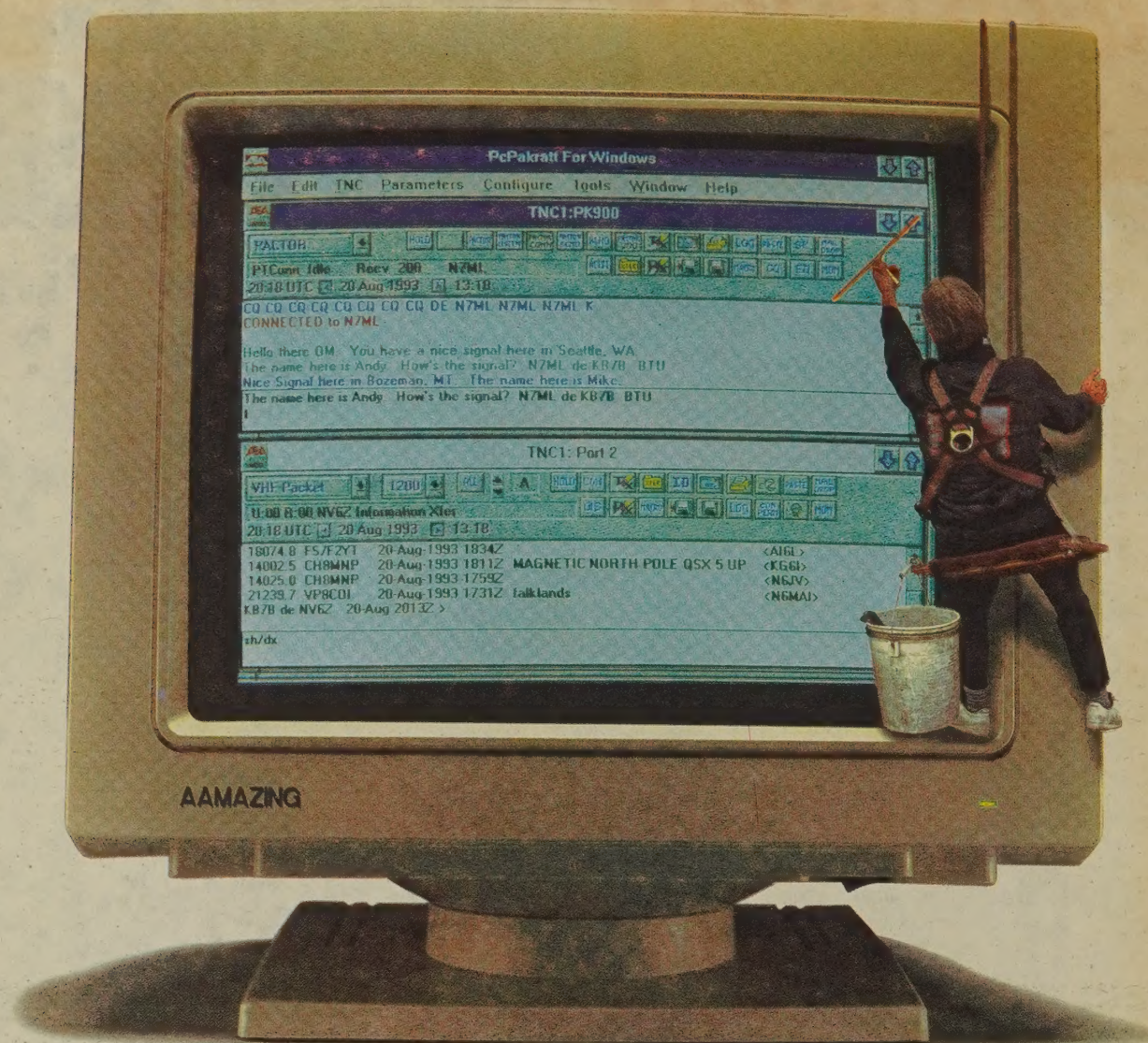
The Commission says the system "... would be useful to the amateur community, yet practical to implement." Currently, it takes about eight weeks to process a new license. The proposal, designated P.R.Docket 93-267, was based on a Petition for Rulemaking from the Western Carolina Amateur Society. *TNX Westlink Report, No. 661, November 12, 1993.*

Invisible Power Fields: Is This Place Safe?



Every day, we are bombarded with radiation from a wide variety of sources. Transmitters, microwave ovens, cathode ray tubes, antennas—even radiation from the sun can be a health hazard. But what about radiation from nearby power lines and wall sockets? Are 60 Hz power fields safe?

Turn to: "60 Hz Power Fields: The Latest Danger" on Page 8.
(Photo by Charles Warrington WA1RZW.)



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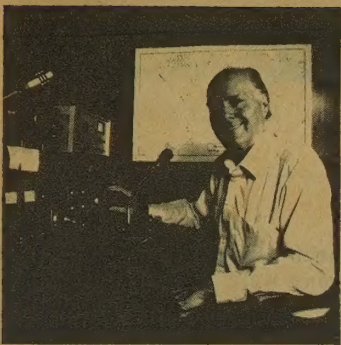
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QLF

by Wayne Green W2NSD/1

Let's Restructure Amateur Radio

Do we really need so many license classes? Do they serve any useful purpose today? And how in hell did we get into this stupid mess? The answers are: no; no; and I'll try to explain.

When I got interested in amateur radio the old-timers were still grousing about being forced to stop using spark. "Spark Forever," was the cry. If bumper stickers had been invented then, I'm sure there would have been a brisk business in selling them. We're talking the mid-1930s.

At that time we had three license classes: A, B, and C. The proposition was that since operating a voice transmitter was more technically complicated than a CW rig, phone operators should be tested to make sure they knew what they were doing. The entry license was Class B, and that permitted us to operate on any band on CW, but not on phone on 20 and 75 meters, where we had 100 kHz phone segments.

Considering that with AM all it took to fill these two Class A bands was nine simultaneous contacts in progress, I suppose it was helpful to keep out the peons. In those days a kilowatt rig was almost prohibitively expensive. The 500-watt modulation transformer alone separated the rich from the almost-rich. That transformer cost around \$5,000 in today's

dollarettes. The final and modulator tubes ran around \$500 each. The result of this was that the 75 meter phone band was virtually the private preserve of a small group of wealthy hams who sat there night after night, talking to each other on nine private round tables. Any ham who got his Class A license and then tried to call into these round tables with a 50-watt signal was just ignored. If he was really persistent they'd eventually acknowledge him and allow him to make a transmission, then they'd never give him another chance to talk. He'd (hams were hes) eventually get the message: Go away, kid.

On 20m another handful of kilowatts held sway, working DX. I forget how much the Collins KW-1 cost, but I think it was around \$100,000 in today's Monopoly money. It looked like a commercial broadcast transmitter and was priced the same. Wealthy hams bought 'em. I remember visiting Mike Ercolino of Telrex in the mid-1950s and being impressed by his. He went on the air with it, plus his humongous antenna array, and called CQ Burma. When he stood by there were a dozen Burma stations calling. Sigh.

The Class C license? That was a mail-order license for hams living more than 75 miles from an examining point. It provided the same privileges as the Class B license. Yes, there was a whole bunch of cheating going on with it. I remember when the

editor of a ham magazine I could name (which is still around) got Class C licenses for the whole staff, even though none of 'em knew the code or had even a slight knowledge of theory or the rules. He merely sent in the exams using Maine addresses, then later they had the addresses changed to New York, thereby avoiding the FCC examiners.

One other thing about the Class B ticket—you had to wait for two years before you could upgrade to Class A. Most Class B licensees stuck to CW, with 40m being the main band. We were all crystal-controlled, and crystals weren't cheap—about \$75 each in today's money. It wasn't until after WWII that variable frequency oscillators (VFOs) and higher power rigs became popular, largely as a result of a few thousand tons of surplus war equipment being sold at bargain prices.

Before the war, with the exception of the Collins KW-1 and the National-600, there were no commercially-made transmitters or even kits. The National-600, by the way, cost \$1,200 when it was introduced, and that's around \$25,000 today. I managed to buy a used 600 in 1947 at a bargain and it kept me going on 75m with a wallop signal for over 20 years. The power supply, modulator, and modulator power supply from that powered my 2m kilowatt up on Mt. Monadnock, giving me a signal that could be heard 600 miles away, even on a lousy night. Thousands of hams all up and down the East Coast made New Hampshire contacts as a result of my station on the mountain. My 336-element beam helped too. My final amplifier was a surplus Army FM rig.

Then, over the ARRL's dead body, the FCC introduced the Novice license. That happened only because the FCC chairman, George Sterling W1AE, was a ham. This broke the gates and we soon had the Technician license, then the Extra, and so on—none of which, to my mind, we have ever really needed.

I started fighting for a no-code license in 1956

when it was proposed at the ARRL National Convention in Washington. It sounded like a great idea to me. I remember that convention because the *Drum* (SS-228), my old submarine, was on display at the Washington Navy Yard and many of the hams from the convention were bussed over to visit it. I had a wonderful time showing 'em around the boat. In order to qualify as a submariner you have to know how to use every valve and control on the boat.

Speaking of the *Drum*, back in the '70s the crew started organizing yearly reunions. At first I didn't want to go back and meet a bunch of old men that I'd known as kids 30 years earlier. That makes you face up to your own growing older. But then I started going and soon was publishing a newsletter as a way to get more old crew members to come to the reunions. The *Drum* was, by that time, on display where it is today, in Battleship Park in Mobile, next to the battleship *Alabama*. I wrote about our many exciting adventures during the war on the *Drum* for the newsletter. Now I've started editing these and will eventually have them available as a booklet for anyone interested in what submarine life was like during the war. If you saw *Das Boot*, you have an idea. When I have the project done I'll let you know. I think you'll enjoy reading this slice of my life of 50 years ago. It was quite an adventure.

Before the war we Class B hams were restricted to phone on 160m and 10m and above. I was active on 160m with a 6L6 crystal oscillator, modulated by a 6L6. There were hundreds of us around New York City using these simple rigs and we had a great time. The 160m voice band went from 1800-2050 kHz, and there were very few blockbuster signals, so we didn't have to deal with a lot of QRM.

10m was for a handful of pioneers in the 1930s. The sun spots were high around 1938 and as a result 10m was hopping. The 5m band was even more experimental, with a few low power modulated oscillator rigs, and very few active stations. 2-1/2

Continued on page 5

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A Few Memories of Radio, Part 2

Relive the golden age.

by Robert C. Green W3RZD

Last month we discussed radio memories up to the end of the 1930s. Let's continue from there.

The manufacturers of amateur equipment were growing, and a few that I can remember were Hammerlund, Millen, Hallicrafters, and Collins. There were also numerous mail-order small parts distributors, and their catalogs were always good reading. The thickest was the one put out by Allied Radio in Chicago.

One very popular amateur receiver was the "Sky Buddy" made by Hallicrafters, which tuned from 550 kilocycles to 30 megacycles. It had a price tag of \$29.95, which was fair for what it would do. I will never know how many hours I spent, or how many gallons of midnight oil I burned, listening to my "Sky Buddy." It was fun listening to the propaganda put out by Berlin and Rome, and from both sides in the Spanish Civil War. Several Saturday afternoons I was able to pick up "Hawaii Calling," a musical program shortwaved from Hawaii to the NBC network. Needless to say, amateur stations from all over were tuned in. I was bit; I had to get an amateur license and join in the fun.

Technology Marches On

In the late '30s TV was beginning to emerge from the laboratories. RCA set up a demonstration site in Washington for the FCC, and I was lucky to be able to see TV. The TV receivers used a special tube called a cathode-ray tube for the picture. The tube was mounted vertically in the cabinet and used a mirror for viewing. A year or so later console receivers for the home began to feature built-in phonographs, and some were "equipped for TV," which was just an input for TV audio.

Another big selling point was "Magic Eye" tuning. The magic eye was a 6E5 electron-ray tube. The face, or end of the tube, had a screen with a green glow, that would produce a varying width shadow to indicate the strength of the received signal. You were tuned in when the shadow was minimum.

By the late '30s and early '40s, low-powered independent broadcast stations, using 250 watts, started to appear on the radio dial, trying to get some of the mushrooming business away from the networks. Network stations were beginning to move their transmitters to the suburbs, while keeping their studios in the city. Radio was growing up fast. Magazine articles described Edwin Armstrong's new type of radio, called "Frequency Modulation," that claimed to be static-free and have better sound. There was even an experimental FM station on the air operating in the 40 megacycle band.

Just before WWII, I got a job as an engineer with one of the small stations in Washington, D.C. I had made up my mind many years before that the only work I ever wanted to do was broadcasting, and now I was there. At the station, I did everything from transmitter and control board stints to going on remotes (programs originating outside the studios). This was fun, even when I had to lug heavy line-amplifiers loaded with "B" batteries. That's right,

batteries were still in use, and spares were always carried in the suitcase that held the microphones and cables. We did remotes of the Navy Band, trials from the traffic court, civic events, football, and ice hockey games. After World War II started, we did several pickups of War Bond Rallies featuring movie and stage personalities.

Most of the recorded music played in broadcast stations at that time was on 16-inch transcriptions, called ETs, at 33-1/3 RPM, and on each side were five or six songs. On the occasions when a station had to make a recording it was made on a disc. Magnetic tape recording was unknown.

Most amateurs were still using horizontal antennas, although broadcast stations had started using vertical antennas as early as 1935. But WWII brought about a lot of vertical antennas.

After I joined the Coast Guard as a radio technician, I worked with frequencies that seemed unreal. Now I had a chance to study that new thing, radar. These frequencies used a small dish for an antenna, which was also something new to me, and used a new type of transmission line called "waveguide." Low-band radars had antennas that looked something like a bed-spring standing on its side, supporting

general profited from the introduction of flexible coax. What World War I did for aviation, World War II did for electronics.

The End of World War II

After the war, experimental FM broadcast stations went on the air. We were now using tubes that were called acorns, octals and lockals. It wasn't long before some of the tubes had 12 pins, and there were miniature tubes called nuvistors.

I went to work for a network station in Washington, first as an AM transmitter engineer and then later at the FM and TV transmitters. Television had begun to stick its head up and look around, and in 1950 over four million sets were purchased. TV stations were on the air between 6 p.m. and 11 p.m. with local programing, but in a short time programing was scheduled from noon to late night.

The East Coast was the hub of TV, and cities were linked by microwave relay stations operated and manned by the networks. Cities to the west and on the West Coast that carried Eastern shows had to rely on kinescope recording (movie film taken off the face of a picture tube), delivered by airmail or special planes. Cities in the East got West Coast shows in the same

how their products would look. All TV programs were "live," and some of the mistakes were quite funny, and embarrassing to the performers. A collection of those moments would make up a thick book. Those were the days of REAL TV.

Magnetic audio tape recording was also coming into its own during this time. We have the Germans to thank for magnetic recording. It was brought to this country as a prize of war, first as magnetic wire recording and then developing into tape. Videotape recording, even though it was being played with, was to come later. It seemed that everybody had to have a TV. Picture tube size ranged from three inches to 10 inches. Seven inches seemed to be the most popular. The RCA 630, with a 10-inch tube, was the standard of the industry. For a while several companies even offered TV receivers in kit form.

I transferred to studio work as it seemed it might be more fun than just sitting in a chair at the transmitter and monitoring programs off the air. Although, at times it was quite a job to keep that 5,000 watt, water-cooled transmitter on the air. I thought I had fun before, but this was great! There were TV remotes from the White House, Presidential news conferences, pickups from government buildings, House and Senate hearings, and inaugural parades. On several remotes we were only 50 miles from the studios, but had to struggle to send a picture that distance with microwave transmitters that had less than 1 watt of power. Many times it was necessary to use a second remote pickup truck and relay the signal through it, so we could get a line-of-sight transmission path.

During the Cuban missile crisis in October 1962 we lived at the studios, 24 hours a day for 22 days. We went home just long enough to take a shower and change clothes. Cots were brought in and the building cafeteria served free meals around the clock.

When President Kennedy was assassinated in November 1963, it was another bad time. The network sent in trucks with remote and microwave equipment, from stations all over the eastern part of the country. We had to cover the Naval Hospital at Bethesda, Maryland, when his body was brought there; the Lying-in-State at the Capitol, the funeral parade and funeral at Arlington National Cemetery. This was another time we lived at the studios.

During this time all of us were getting our fingers into two new things, color TV and videotape. All-in-all, these were fun days and nights, developing new TV programming techniques, installing new equipment and then ironing out the bugs. Speaking of videotape, did you know that Bing Crosby had quite a lot to do with developing videotape? His program was the first to use an all-tape format.

The last major TV story that occurred before I retired was the assassination attempt on President Reagan. Another hectic time was had by all.

But I've gotten a little ahead of my story. After the war my wife and I were living in an apartment that had a 6- by 15-foot wooden balcony, and the balcony soon became my antenna farm. A long wire antenna was tacked along the balcony rafters.

Continued on page 6

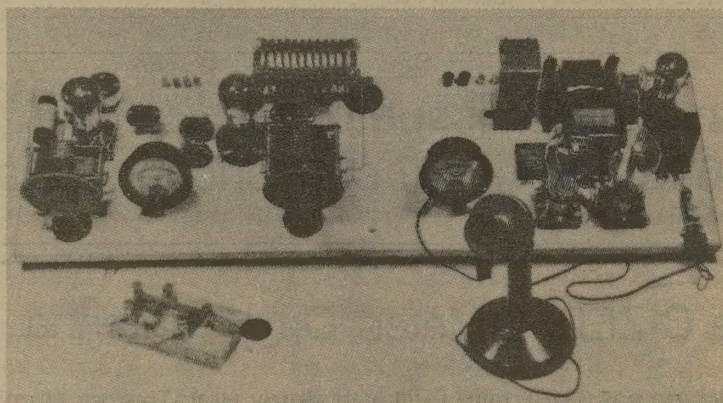


Photo A. Phone transmitter, circa 1930.

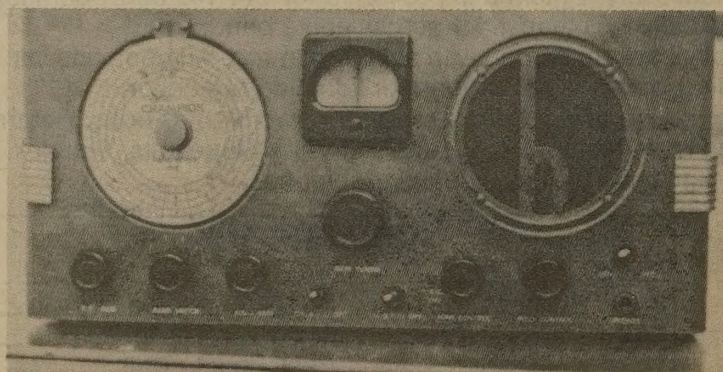


Photo B. Hallicrafters: state of the art.

half-wave antenna elements.

Those tubes I mentioned that went into portable radios, well, they had a lot of use when they joined the war; all kinds of portable equipment was being used. Before the war ended we were using frequencies that seemed out of this world. The modern-day pleasure boater can thank the war for radar and sonar, and radio in

manner. It was a few years before the telephone companies were able to furnish city-to-city and coast-to-coast coax cable circuits.

Inter-city cable was in by the middle fifties, and on some Saturday nights two hours of network color TV programing was broadcast. It was done to sell color TV to the public, and to show sponsors

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QLF

continued from page 3

meters was much more active. It ran from 112-116 MHz, and again was all modulated oscillators. I built a pair of 76s into a long-lines oscillator. I had to saw the tube base to get these tubes to work at that high frequency.

Imagine my surprise a couple years later when I found that the SD radar was on 112 MHz! This was the radar I used on my submarine to detect approaching planes. The antenna was mounted on top of a periscope mast so I could stick it up and check for planes before surfacing. That helped cut down on nasty surprises. The only problem was that the Japanese started equipping their planes with 112 MHz receivers so they could pick up our radar and zero in on us for a bombing run. It was at about this time that the magnetron was invented, moving our new radar systems up to 3,000 MHz. I saw no signs that the Japanese ever had any receivers to track these signals, even when we were right in the middle of Japanese convoys at night and picking their troop ships off. At any rate, we stopped using the SD and depended on our SJ radar for detecting both ships and planes. It wasn't until almost the end of the war that our SD was finally removed. In the meanwhile we'd added an identification system (IFF) to help us find out whether an aircraft we picked up on the SD was friendly or not. It was not dependable.

After the war our 5m ham band (56-60 MHz) was moved to 6m, which had been an FM broadcast band pre-war. That made it easy for me to get on 6m, using my old Meissner FM tuner for a receiver. 5m was by now a TV channel.

The ARRL's opposition to any expansion of ham voice frequencies—the League had always been totally CW oriented—led to the formation of the National Amateur Radio Council (NARC), and it was this group that got the FCC to open a voice band on 40m, again over the strong and endless objections of the ARRL. They'd achieved this just prior to the war, but we were put off the air before the band was opened. After the war the NARC continued to grow and have more influence, not only getting us the 40m phone band, but also getting the 75m phone band doubled in size, and expanding the 20m phone band. Once the phone bands had been expanded the NARC's work was done and the organization disbanded.

For several years after the war the 20m phone band went from 14.2 to 14.3 MHz, with DX stations operating above and below this band.

It was the amateur disenchantment with the ARRL in 1962 which got Mort Kahn W2KR, the Hudson Division Director, to come up with the disastrous so-called "Incentive Licensing" plan. He'd just recently fired Budlong W1BUD as the ARRL's general manager and had almost total control of the League. The proposal was designed to be controversial, as a way to focus attention on the ARRL and thus get their membership growing again. It was controversial, for sure. Unfortunately, the actual result of the ARRL's proposal to return the licensing structure to the way it was before the war, with phone privileges just for a select few, brought about the almost total destruction of the industry and wiped out about 90% of our amateur radio clubs. Within two years 85% of our amateur radio stores went out of business and 90% of the manufacturers either went out of business or changed to some other business. Exciting times.

A New Paradigm

Well, all that is water over the bridge. We're in the 1990s now and everything except the ARRL has changed. The no-code license, despite the years of bitter opposition by the League, has been an overwhelming success. Now there are some amateurs who are cautiously wondering whether the whole code thing isn't so antiquated that it should be removed as an obstacle to getting a license.

My view is that we need to completely restructure the hobby. By that I mean that it's time for us to start with our basis and purpose (97.1) and re-invent the reasons for amateur radio to have the exclusive use of billions of dollars in public property—our bands. I believe we can be well worth this investment if we can get rid of the old-timers who are looking backward instead of forward—looking back at radio relaying via CW traffic nets. Sure, this was necessary in the early 1920s, when long-distance communications called for relaying. But today we have 9600 baud and higher throughput packet, we have fast- and slow-scan TV, we have moon and meteor bounce communications, satellites, and so on.

I believe we can justify our country's investment in our bands if we provide the country with a continuing source of high-tech career scientists, engineers and technicians. We know beyond any question that technology is the key to the future success of our country. We know that we have to get our kids interested in high-tech when they are young and provide them with the schools they'll need to compete with the rest of the world. We can't afford to continue turning out illiterates, both in reading and science.

This means that we amateurs have a responsibility to rebuild the school radio club infrastructure which was destroyed 20 years ago by the ARRL's Incentive Licensing docket. We need to return to the amateur radio of the '40s and '50s when 80% of our newcomers were teenagers, and when 80% of them went on to high-tech careers. We can do this, with or without the cooperation of the League, but it means that every radio club in America has a responsibility to help their local schools form radio clubs. It means getting out and talking to kids in the 5th and 6th grades and getting them excited about talking around the world, about foxhunting, repeaters, packet, SSTV, satellites, and so on. We have more to offer kids than any other scientific hobby and we should be taking advantage of this.

License Classes

Once we've decided on how to re-invent our hobby we'll need to decide on what barriers we should place to its entry. Do we need six license classes? Do we even need three? For what? Ask me what I'd like to see.

Lucky you asked. I'd like to see one license. Yes, I know every argument that you'll have. Hey, I've been talking at hamfests and conventions, and I've been writing editorials for 42 years and getting tons of mail as a result. I've made who knows how many hundreds of thousands of contacts. I know all the pros and cons, and I haven't heard a new argument in years—just endlessly repeated brainless baloney about the ham bands turning into CB and so on. I don't want that any more than you do. And no, it has nothing whatever to do with my making or losing money with my magazines. I'm making my money in the music business these days and my ham magazines are mainly a break-even proposition, which is all I ask. Before the music business I was doing fairly well in the computer business. Remember? Though I can take almost any salary I want, I'm doing just fine on a lot less than you're probably making. Why should I waste money on a salary I don't need or want?

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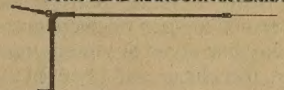


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CIRCLE 64 ON READER SERVICE CARD

Continued from page 4

and it worked pretty well with an antenna tuner made from a surplus military radio.

Hams really profited from the war due to the surplus military electronics available to them. Stores selling surplus equipment seemed to open on every corner. You could buy just about anything you wanted in radio, dirt cheap, and I bought my share of it. It would be almost impossible to count the number of articles in ham magazines describing modifications to ARC-5 and SCR-274 receivers and transmitters. Probably a million or more of these were built, and were used in everything that rolled, flew or floated. They were probably the best of all surplus electronics. Untold numbers of hams, both new and old, got on the air with these rigs. I shouldn't forget the 522s that were fired up on 2 meters. I wonder how many antenna tuners were built from BC-610 units, and are still around. They were well-made and had beautiful parts in them.

Millions of crystals were on the surplus market, selling for 50 cents or less. Ham magazines had articles on how to regrind crystals to the frequency you wanted. And the tubes you could buy surplus, both receiving and transmitting types, seemed unlimited. Many a ham went on high power for the first time when he got his hands on those tubes. All that surplus made for a ham's paradise.

Unfortunately, I couldn't do too much operating due to TV interference. TV viewers didn't want to miss "Uncle Miltie" or "The Ed Sullivan Show." In those days hams referred to TVI as "Tennessee Valley Indians," and a "War Whoop" was a complaint. Before we moved to a house, that balcony saw many antennas: a flag



Photo C. Modern station NN3SI at the Smithsonian Institution is demonstrating amateur radio to the visiting public. John Swafford W4HU is the operator on duty.

pole for 6 meters, a curtain rod for 2 meters, a TV antenna made of 300 ohm twin lead, and a large number of odd and strange-looking wires.

I won't say much about the good times I had after we moved to a house, except it had a large yard for more antennas, and more space to store surplus junk and goodies purchased at hamfests. There was also room for a workbench in the basement—no more building gear on the kitchen table.

On Friday, October 4, 1957, Russia launched "Sputnik," the first satellite. What an explosion it made in news stories! The next Sunday I was on my way to a hamfest, operating mobile on 6 meters with a

Gonsset Communicator, which was a darn nice transceiver. All the guys on the air were talking about Sputnik, and a few of them even said they had picked up signals from it.

Later, after this country had put up communication satellites, I saw the first live TV show that was received from Europe. I just stood in awe and wondered what was next. I believe everybody that worked at the station was there, crowded around the monitors to see the miracle that had fallen on the industry. Their thoughts must have been the same as mine.

A new magazine just for radio amateurs came out in October of 1960. It had a good

ham name, 73, and sold for 37 cents. I still have a copy of that first issue.

Amateur Slow-Scan Television, SSB and FM repeaters were getting underway. CB radio was approved by the FCC and everybody had to have one. Then, you had to have a CB license, and the call was made up of three letters and four numbers. The influx of CB did bring some operators into the ranks of ham radio, and bring about some goodies for our use. One thing it gave us was crystal synthesizer circuits.

I already mentioned the radio parts catalogs and what good reading they were. Well, not long ago I found a 1972 Radio Shack catalog in the attic, and reading through it brought back memories. Would you believe it if I told you that catalog listed over 1,000 different tube types, but only 20 types of transistors and nine ICs? It also listed a package of five tubes for AC-DC receivers. I guess there were a few of those sets still about. How times have changed. What surprised me is that the prices of some of those parts hasn't increased very much in the last 20 years.

A lot of water has passed over the dam since I got started in radio, and I got my feet pretty wet sometimes, but I haven't regretted any of it. When I say I had fun in radio, both amateur and broadcast, I mean it. And you young people who can't make up your mind whether to jump in, don't think it's all over yet. Just about every day I read or hear of new things in radio that make me envious of those poking their noses into these new trends. We opened the door for you, now you have to see what's on the other side. Believe me, it's going to be FUN.

RF

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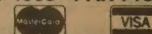
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CIRCLE 34 ON READER SERVICE CARD

Fork It Over

If you think your last traffic ticket was painful, wait until you see what your friends at the FCC have cooked up for you. The commission's new fine schedule includes a \$625 penalty for any "assorted minor violations," and a \$1,250 fine for failure to identify your station. Unauthorized use of equipment will cost you \$5,000.

Running excessive power, failing to respond to an FCC communication, or operating on an unauthorized frequency will set you back \$10,000 under the new fine schedule. Transmitting indecent material or words will cost you \$12,500, causing malicious interference to another ham is set at \$17,500, and failing to permit an FCC station inspection carries an \$18,500 fine tag.

If you really want to help reduce the national debt, just get caught sending out a false SOS. Illegal misuse of distress communications like that will cost you \$20,000 for each transmission! The FCC has the authority to adjust these fines, but these base amounts are recommended for first-time offenders. *TNX Newsline & Westlink Report*, No. 661, November 12, 1993. **RF**

QLF

Continued from page 7

What I'd like to see is all newcomers being trained by ham clubs in our rules, the fundamentals of electricity and radio, and on how to operate. I'd like to see the clubs then examine these kids and license them. Then I'd like to see a fairly simple procedure for de-licensing anyone who misbehaves, with the responsibility lying on the club that issued the license. Make sense?

I was one of the first to propose that the FCC let us do our own examining—the present VEC system. That was a good step ahead. Now I'd like to see the power of our hobby rest with our clubs instead of the League. I'd like to see regional club conferences, with a national conference every two or three years. I talked with the FCC commissioners about this and they liked the idea. These national conferences would provide a way for us to change our rules.

There's a lot more details, but I know your attention span is short, and if I gave you all the details I have in mind I'd spoil your fun in arguing against my ideas.

Should we replace the code barrier with a higher technical barrier to getting a license? Should we make the licensing process one which requires applicants to actually understand theory instead of just memorizing some Q&As? Should we issue a license to anyone who applies? Right now, I doubt we could give ham tickets away on street corners for free.

Remember, before you can operate on CW you have to be able to send and receive code. Before you can get on packet you need a station, a computer, and the know-how to use 'em. We don't need exams for things like that. So let's decide what we think is really important as an entry exam for the hobby and get rid of the stuff that's a waste of time. Once we get newcomers into the hobby, it's our job to encourage them to learn and to help them try more and more of the exciting things we have to offer. **RF**

Let's Talk Ham Radio

A Phoenix-based radio talk show called "Ham Radio & More" has gone national after 2-1/2 years of success on station KFNN. The show began broadcasting nationally over more than 80 Talk America Network affiliate stations in

late November. The weekly program is hosted by Len Winkler KB7LPW, and features special guests, give-aways, listener call-ins, and DX news.

"Ham Radio & More" can be picked up in any market by a local talk station. You can suggest your favorite station carry the program by having them contact the Talk America Network

at (508) 460-0588. The show can also be picked up on Satcom C-5, Transponder 19, 6.0 audio and Galaxy 2, Transponder 3, Channel 55.4. The show is designed to increase the public's awareness of ham radio and thus help the hobby to grow. It includes discussions of all aspects of hamming, and is not limited to technical topics. Listen for it on Sundays at 6 p.m. EST. **RF**

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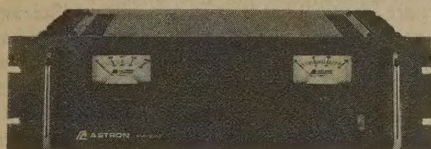
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MODEL	Colors Gray Black	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
SL-11A	• •	7	11	2 1/2 x 7 1/2 x 9 3/4	12
SL-11R	• •	7	11	2 1/2 x 7 x 9 3/4	12
SL-11S	• •	7	11	2 1/2 x 7 1/2 x 9 3/4	12
SL-11R-RA	• •	7	11	4 1/4 x 7 x 9 3/4	13

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MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-4L	3	4	3 1/2 x 6 1/2 x 7 1/4	6
RS-5L	4	5	3 1/2 x 6 1/2 x 7 1/4	7

• 19" RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RM-12A	9	12	5 1/4 x 19 x 8 1/4	16
RM-35A	25	35	5 1/4 x 19 x 12 1/2	38
RM-50A	37	50	5 1/4 x 19 x 12 1/2	50
RM-60A	50	55	7 x 19 x 12 1/2	60
• Separate Volt and Amp Meters				
RM-12M	9	12	5 1/4 x 19 x 8 1/4	16
RM-35M	25	35	5 1/4 x 19 x 12 1/2	38
RM-50M	37	50	5 1/4 x 19 x 12 1/2	50
RM-60M	50	55	7 x 19 x 12 1/2	60

MODEL	Colors Gray Black	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-3A	• •	2.5	3	3 x 4 1/4 x 5 3/4	4
RS-4A	• •	3	4	3 1/4 x 6 1/2 x 9	5
RS-5A	• •	4	5	3 1/2 x 6 1/2 x 7 1/4	7
RS-7A	• •	5	7	3 3/4 x 6 1/2 x 9	9
RS-7B	• •	5	7	4 x 7 1/2 x 10 3/4	10
RS-10A	• •	7.5	10	4 x 7 1/2 x 10 3/4	11
RS-12A	• •	9	12	4 1/2 x 8 x 9	13
RS-12B	• •	9	12	4 x 7 1/2 x 10 3/4	13
RS-20A	• •	16	20	5 x 9 x 10 1/2	18
RS-35A	• •	25	35	5 x 11 x 11	27
RS-50A	• •	37	50	6 x 13 3/4 x 11	46
RS-70A	• •	57	70	6 x 13 3/4 x 12 1/2	48

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
• Switchable volt and Amp meter				
RS-12M	9	12	4 1/2 x 8 x 9	13
• Separate volt and Amp meters				
RS-20M	16	20	5 x 9 x 10 1/2	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13 3/4 x 11	46
RS-70M	57	70	6 x 13 3/4 x 12 1/2	48

• Separate Volt and Amp Meters • Output Voltage adjustable from 2-15 volts • Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps)			ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt. (lbs.)
	@13.8VDC	@10VDC	@5VDC			
VS-12M	9	5	2	12	4½ x 8 x 9	13
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

• Variable rack mount power supplies

VRM-35M	25	15	7	35	5¼ x 19 x 12½	38
VRM-50M	37	22	10	50	5¼ x 19 x 12½	50

MODEL	Colors Gray Black	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-7S	• •	5	7	4 x 7 1/2 x 10 3/4	10
RS-10S	• •	7.5	10	4 x 7 1/2 x 10 3/4	12
RS-12S	• •	9	12	4 1/2 x 8 x 9	13
RS-20S	• •	16	20	5 x 9 x 10 1/2	18
SL-11S	• •	7	11	2 1/2 x 7 1/2 x 9 3/4	12

*ICS—Intermittent Communication Service (50% Duty Cycle 5min. on 5 min. off)

CIRCLE 16 ON READER SERVICE CARD

60 Hz Power Fields: The Latest Danger

What you don't know can hurt you.

by Paul Danzer N1II

We have been reading and hearing about the dangers of RF radiation for some time now. Leakage from older microwave ovens, cellular phones, handie-talkies—all of these are known producers of RF radiation. The possible effects are scary. For example: If you put meat in a microwave oven or any other strong RF field it will cook!

But now many scientists are warning us that the 60 Hz power which we use in our homes and ham shacks may also be hazardous to humans. This problem is different from the RF cooking problem, but it is still something we need to carefully examine!

Any time you have wires with a current flow you will have energy being radiated into the surrounding area. Part of the energy is in the form of an electrostatic field, and it varies with the voltage present. The other part of the energy is in the form of an electromagnetic field, and it varies with the amount of current flowing. However, since most hams are not exposed to very high voltages without a metal cabinet or shield around the voltage, it is the electromagnetic field which we should first look at.

As you probably remember from your school days, the entire earth has a magnetic field (see Figure 1), which is very handy because it lets us use such nice devices as compasses to navigate. Therefore, we are always surrounded by a magnetic field, but the earth's field is DC. That is, it maintains the same orientation all the time and does not alternate or reverse direction like the fields caused by 60 Hz power conductors.

The real question with the 60 Hz power lines surrounding us is whether there is need to worry about radiation. Are the sort of mag-

netic fields we are exposed to each day in our shacks and our homes dangerous? Millions of dollars are being spent at this minute to try to answer this question. There are many debates over mountains of evidence, and no real definitive answer yet. But since there is a real question, we should take a look at how strong the fields are which surround us. Then when we read in the newspaper or hear on CNN about the results of some of these studies we will have an idea to what extent they might affect us.

Where Do the Fields Come From?

Whenever current flows, a magnetic field is generated. Years ago it was considered fun to determine the direction of the magnetic field around a wire-carrying current. Old-time hams used to use their thumbs to show the direction of current flow in a wire and their curled fingers to show the direction of the magnetic field. Depending on the definition, either the right hand or the left hand was used to demonstrate the relationship. However, the real importance is shown in Figure 2: When current flows through a wire there is a magnetic field generated around the wire.

If the wire is wound into a coil, the magnetic field is concentrated in the center of the coil and flows around, as sketched in Figure 3. The strength of the magnetic field is generally proportional to the number of turns and the current flowing. Double the number of turns of wire and the field strength doubles; double the current flowing and the field strength again doubles.

When the coils or inductors are part of a transformer, a small part of the magnetic field generated in the transformer flows through the

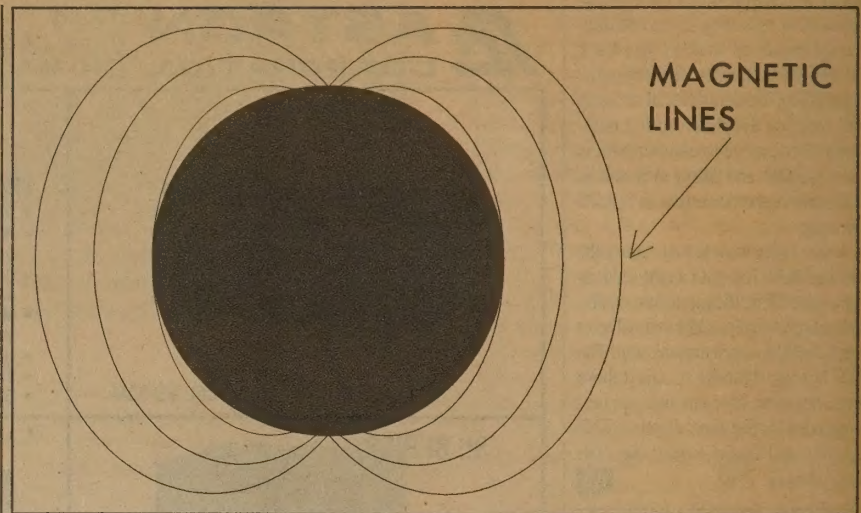


Figure 1. The entire earth is surrounded by magnetic fields. These enable us to use devices like the compass for direction finding.

open air so that if you measure the field around a power company pole transformer (Figure 4) you will be able to detect this open-air field.

You can get one clue from looking at Figure 5. Here two wires, connected to a light bulb, are running side by side. The currents in both wires are identical but flow in opposite directions at any instant. Therefore, the magnetic field surrounding each wire is identical but it is running in the opposite direction. If the two wires are close together the two opposite magnetic fields virtually cancel each other—so if you want to minimize the field from 60 Hz wiring, keep both leads together.

Incidentally, the power company and most manufacturers want to keep these magnetic

fields around transformers, motors, and other devices as low as possible. In these devices energy is transferred by way of the magnetic fields. These fields flow in the metal cores of the devices, and stray fields in the air do not do very much useful work. They just lower efficiency and waste power.

Most houses and shacks are wired with two conductor cables (ignoring the "green" or ground wire). Therefore, the current flow in one wire is supposed to be the same as the flow in the second wire. Unfortunately, occasionally there is a problem or "ground fault," which allows some current to flow in the ground wire or some other conductor. We will take a look at one possible fix for this later.



Photo A. A magnetic field strength meter like the one used in researching this report.

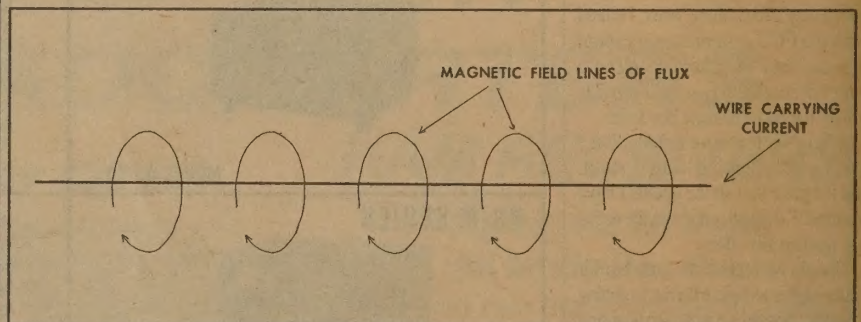


Figure 2. A wire carrying electric current and its magnetic lines of flux.

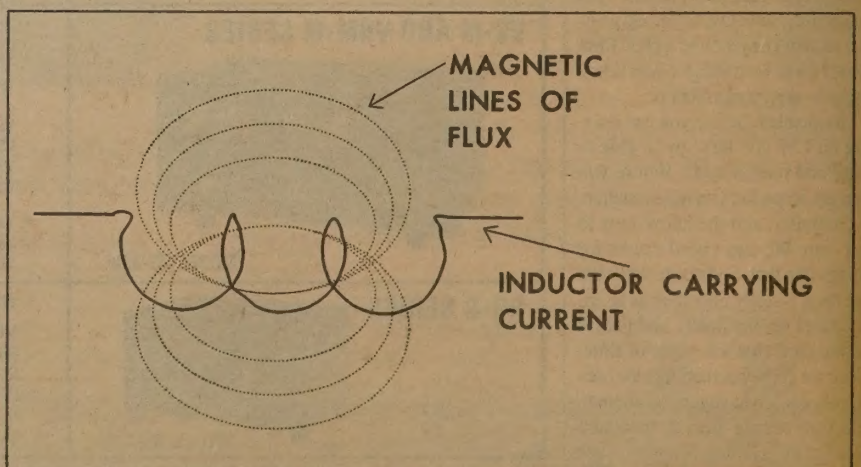


Figure 3. An inductor carrying electric current and its magnetic lines of flux.

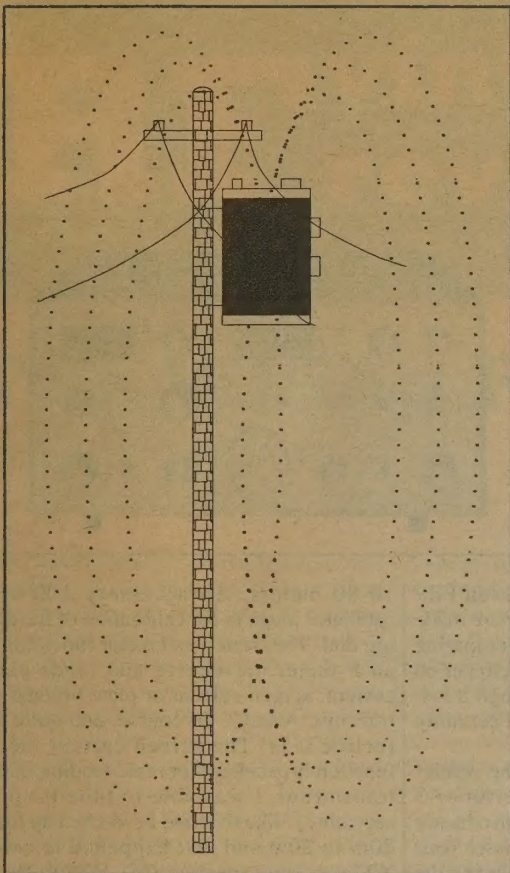


Figure 4. A utility-pole-mounted transformer and its magnetic lines of flux.

How Much is Too Much?

So far, only Sweden regulates magnetic field safety. Their requirement, known as MPR II, is taken very seriously by many equipment manufacturers worldwide. As an example, both American and Japanese suppliers of computer monitors are now advertising that they meet this specification. Even though the danger is not "proven," it is important to people who sit for a long time in front of these electronic devices to know that the magnetic radiation is low. Perhaps we hams, who sit for long periods in front of our rigs, should also take it seriously too.

Without going into the depth and details of the Swedish requirement, it calls for a magnetic field strength of no more than 250 nanoteslas (or nT). This is a measurement unit used in Europe. Here in the United States the usual unit is the gauss, and 1/10,000 of a gauss is one tesla. Therefore, in conventional American units the requirement would be 2.5 milligauss or (mG).

Just to give a little feeling of reality, many

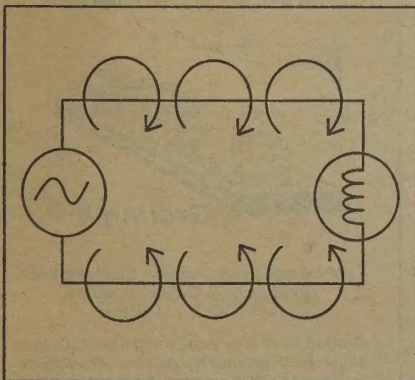


Figure 5. A simple AC circuit consisting of a power source, a lamp, and two conductors. Notice that the magnetic lines of flux in these conductors are in opposite directions.

discussions of these values state that an average of 0.5 mG is common for most houses. This is an average, and is measured by a process of taking a large number of readings around the house and calculating the average.

Measurements Around the Ham Shack

An acquaintance of mine was kind enough to lend me a model 20/25 magnetic field meter (Photo A) made by Magnetic Sciences International in Sausalito, California. He purchased the meter (for less than \$300) when he moved into a new office and found himself staring at a set of high-tension wires on steel towers at a distance which seemed to be less than 50 feet. Under this circumstance, he felt the purchase price was well worth the value!

The meter consists of a sensor which can be plugged into an accompanying digital millivolt meter.

Table 1 is a summary of a number of readings I took with the meter. As you can see, most readings were low and very repeatable. Certain fluorescent ballasts and some power supplies were the only sources of high field strength in my survey.

The low values measured outside near the power company's equipment were a pleasant surprise, but remember that they have been concerned about both health and efficiency for many

years. Obviously, magnetic fields in the air do not deliver power to the intended source very efficiently.

OK, What Should We Do?

At this point we still don't know if there is a real danger but we do have an idea of what goes on in our shacks. Therefore, if there are a few things we can do to improve our health and safety and they neither cost us very much nor inconvenience us, perhaps we should do them.

First of all, move your power supplies. Whenever you have a separate power supply, move it as far from the operating position as the cables will allow. You don't need it right in front of you, and it can be controlled remotely with a surge protector strip. You *do* use one of these strips for lighting and power line surge protection, don't you?

Next, consider changing to a ground fault interrupt outlet (GFI). Most building codes now require them for bathrooms and outdoor outlets anyway, and if stray ground currents are a source of increased magnetic fields the GFI outlet will trip the current off if the stray current is above a preset level. It is not clear how much you can accomplish this way, but GFI outlets are a good general safety precaution, so it won't hurt.

Keep your primary or AC supply wires paired together. If you use ordinary double conductor line cord this requires nothing extra. When you build a project try to keep the supply wires together as well.

Some of the less expensive power supply equipment I measured had higher field strengths. Table 1 only included a small sample of those measured. One clue, and it is no more than a clue, is that when one of the little "brick"-type power supplies ran hot it also seemed to have a high magnetic field strength. This might have been due to poor efficiency.

Examine the new equipment advertisements carefully. Computer monitor manufacturers have found it was good business to meet the

new Swedish requirement, and perhaps ham and other electronic manufacturers will find it is also good business for them.

Finally, keep on reading. Things change as we learn more and more. There is a great deal of money being spent on this problem both by private industry and by governments. Stay up-to-date. How many of you remember when "doctors" in white coats used to extol the benefits of smoking one or another brand of cigarettes, on television?

A Word of Thanks

To Paula Taupier, a Northeast Utilities transmission engineer in Hartford, Connecticut, who was kind enough to supply both literature and contact with other Northeast engineers for information on their lines and transformers. Also thanks and credit to Magnetic Sciences International who supplied the photograph of their meter. Finally, thanks to the local gang who allowed me to invade their shacks to take measurements. **RF**

Table 1. Measurements

Measurements were taken in and around the shacks of a number of local hams. The values given are in mG, which is the abbreviation for milligauss. Where no distance is specified the reading was taken 6" from the front panel of the equipment. Readings of 0.5 or less are usually due to household or shack background, and not the equipment alone.

Two-bulb 40 watt fluorescent workbench fixture measured at the workbench 36" from fixture.	OFF — 4 ON — 4
100 watt incandescent lamp measured 6" from the lamp.	OFF — 0.1 ON — 2.3
22 watt circular fluorescent lamp surrounding a magnifying lens Measured 3 inches from the center of the lens.	OFF — 0.2 ON — 1.0
Ballast for the lamp above, mounted in the weighted base of lamp fixture. Measured 6" from the ballast	OFF — 2.0 ON — 90 (No, this is not a typo.)
Yaesu FT-901DM HF transceiver, new in the early 1980s.	OFF — 0.6 ON — 8.0
Radio Shack PRO 2005 scanner.	OFF — 9.2 ON — 9.2
Heathkit dual-channel 25 MHz oscilloscope IO4225.	OFF — 1.9 ON — 1.9
Radio Shack "Boom Box."	OFF — 3.5 ON — 3.5
Isolated telephone wires, telephone not in use.	3.5
Discount brand power strip with surge suppressor. This was by far the worst of several tested.	OFF — 0.5. ON — 180
KEPKO power supply—a relic of the 1950s.	OFF — 2.5 ON — 120
6" from a PC clone keyboard and NEC 15" monitor (computer 36" away).	OFF — 0.1 ON — 3
Tower case PC clone (metal case).	OFF — 0.1 ON — 0.3
Hammarlund SP 600 receiver.	OFF — 0.1 ON — 1.9
ELMAC AF 67 (rather old transmitter). Power supply is remote.	OFF — 0.5 ON — 0.5
Drake T4 Transmitter (remote power supply) stacked with Drake R4 receiver.	OFF — 0.8 ON — 5.0
PK 232 controller running packet.	ON (only) 2.0
IC28H stacked with ASTRON RS 12A power supply.	OFF — 0.5 ON — 30
12 volt 1 amp Radio Shack power supply RS 273-1653A.	OFF — 0.7 ON — 70
Yaesu FT757GXII HF transceiver next to a FP757HD power supply. Measurement taken 6" from the transceiver's front panel.	OFF — 2.2 ON — 2.5
Yaesu FL2100B linear amplifier with internal power supply.	OFF — 2.7 ON — 46 (non-radiating)
37.5 kVA power company transformer fed by 4.8 kV line, sending 220 volts single phase to several homes. Transformer is at least 15 years old Reading taken at head level below transformer on a 25-foot wooden pole.	0.2 - 0.5, varying with time of day (assume it varies with power consumption in the homes).
15 kVA transformer. Same condition as above. Transformer probably over 30 years old.	0.1 to 0.2
Random points below 4.8 kV feeder lines on 25-foot wooden poles.	0.1 to 0.2 (No real indication there were power lines in the vicinity.)
27 kV area feeder lines on 50-foot poles.	16 to 70 measured. Variation with load. Usually when it measured at the high end. Within 15 to 30 seconds the reading went back down to 16 to 20. Probably due to changed loading or load balance on the lines.

RF vintage review

Testing the NCX-1000

by Wayne Green W2NSD/1

Reprinted from the April 1971 issue of 73 Magazine.

After five years of making waves on the DX bands with a transceiver plus a great big linear amplifier, it takes some getting used to making virtually the same waves with a little box that I can lift with one arm. Well, two arms—it weighs 59 pounds. And that includes the built-in power supply and loud-speaker.

The NCX-1000 is sure a far cry from the first National rig that I owned way back in the dim, dark past. The National 600 was a 600 watt transmitter first marketed back in the late '30s. I still use the indestructible power supplies and modulator from the 600 in my 2 meter kilowatt. The RF sections are, sadly, no longer state of the art.

Well, to get back to the 1000, National has come up with a real beauty in this rig. It is all solid-state except for the final stages of the transmitter and it works like a dream.

Being a knob buff, a fellow who enjoys having dozens of knobs to twiddle, I was at first taken aback by the simplicity of the front panel of the 1000. Surely National must have left off some controls that I would need. If they did I still haven't missed them.

How does the 1000 compare with other rigs? Well, I stacked it up against three other transceivers on my operating desk, all

working through a nice linear amplifier, and started making comparison checks all around the world, through poor conditions, monumental interference, and such. While there did turn out to be times when the extra power of the big rig surmounted pile-ups a little faster than the 1000, these times were satisfyingly few. Generally the report is that the 1000 is better copy.

If I had been using different types of microphones it might account for the better voice reports, but I used identical mikes for the tests. The engineers at National have emphasized the higher range of the voice a bit more than the other rigs, with the result that there is more punch and, other things being equal, the 1000 is more readable.

The NCX-1000 covers the amateur bands from 10-80 meters and provides sideband with either side, AM, and CW. The receiver works so well that I suspect National must have borrowed more than considerably from their very successful HRO-500 receiver for the design.

They have a clever speech processor built into the transmitter (switched on from the front panel), which operates at RF. In this circuit the single sideband of the first IF is clipped by a diode limiter and then filtered to remove the unwanted distortion products. This increases the average power by a factor of two, resulting in almost the same

average power output as a 2 kilowatt PEP transmitter. My tests, by the way, were made with this clipper off when I was comparing the 1000 with other rigs. With the clipper on the signal is even louder, and though it loses a bit on voice quality reports it certainly gains on punch through pile-ups.

CW operators will appreciate the vernier control which displaces the receiver ± 3 kHz from the transmitter. This is also handy on sideband when the other op misses your frequency or drifts away from it during the contact. It can keep you from chasing someone with a displaced transmitter on down or up the band. An accessory VFO is available if you want to work split frequency more than 3 kHz.

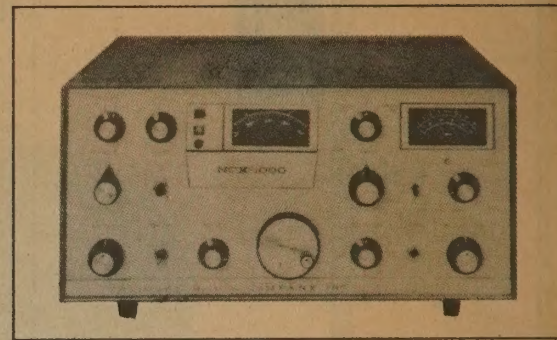
It is strange that it has taken so long for solid-state circuits to come to amateur sideband equipment. You don't find tubes in much new gear these days, except for amateurs. My car radio, FM receiver, television set, tape recorder, hi-fi, etc., are all solid-state. Even the silly pencil sharpener is solid-state! Out of one dozen 2m FM sets on the market, all are completely solid-state except two . . . and both have one tube which will be superseded soon by an *all* solid-state unit. Judging from the small size and light weight of the National 1000, solid-state is certainly the way to go.

The 1000 covers all five amateur bands,

10-80 meters. An accessory 100 kHz oscillator plugs in for calibration of the tuning dial. The front panel meter functions as an S-meter on receive and reads plate current, screen current or plate voltage on transmit. AALC? Of course, and quite effective it is. The screen current meter function is excellent for rapid loading of the transmitter. I was able to tune it up in seconds . . . like the time I switched up from 80m to 20m and just happened to catch XT2AA (rare) calling CQ. Within three seconds I was tuned up and calling him. I made it.

The accessory 100 kHz calibrator also provides sidetone for CW operation. It can even be used for code practice, if needed! Obviously National has kept the CW ops in mind in the design of this rig . . . it covers all CW bands . . . and runs close to the legal limit to the 8122 final in this mode.

In all, the National 1000 seems to be well in keeping with the long history of excellent equipment that National has provided us down through the years. Many of us were concerned recently when their overdependence on government work forced them into bankruptcy. The company seems to be in pretty good shape now and is paying its bills, so perhaps they have weathered the depression.



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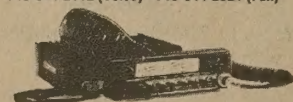
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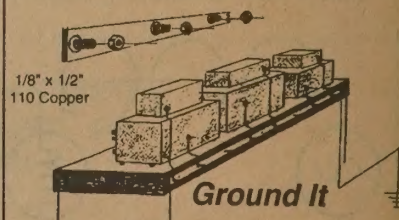
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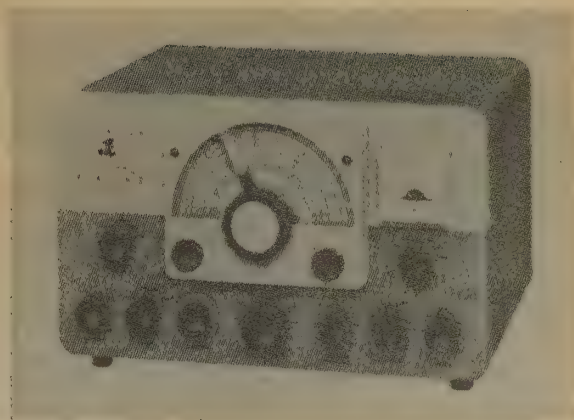
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RF vintage review

The Viking Ranger II

by Charles E. Spitz W4API



The Viking Ranger probably needs less introduction to the amateur fraternity than most any other piece of gear. It was the creator of the trend towards making a small and complete transmitter package by the incorporation of an integral VFO. No out-board gadgets other than your mike, key, crystal (if you desire), or antenna relay is required to put you on the air on any band from 160 to 6 meters. The Ranger II incorporates all of the modifications and improvements brought out for the basic Ranger to date, wrapped up within a new two-tone gray ventilated steel cabinet.

The Ranger II is designed to meet the needs of the greatest possible number of amateurs: General, Technician or Novice, CW or AM phone, the 6 meter enthusiast or the 160 meter specialist—and all of the bands in between, all as a fixed station or portable. In addition, the RF section may be used as an RF exciter to drive anything in the kilowatt class, and the audio section will drive any high power modulator. Physically it is small, 15-1/2 inches wide by 9-5/8 inches high, and 14 inches deep, weighing in at 43 lbs. The input of 65 watts on AM phone and 75 watts for CW will work anything in the world.

Oscillator Circuitry

It would be well to follow the block

diagram of Figure 1 to clearly picture the whole of the transmitter system and its component parts. The oscillator is the heart of the Ranger II. Separate calibrated band-spread dial scales are provided for each of the seven bands and 6-to-1 ratio planetary drive mechanism results in excellent tuning accuracy and smooth control. The Plexiglas dial is edge-lighted. Ten kilocycle calibration increments on each band provide uniform and accurate dial interpolation. Although frankly not designed for frequency meter accuracy, checks with a 100 kHz crystal oscillator will excite your admiration. The VFO employs a series-tuned Colpitts circuit with a 6AU6, using two separate tanks. One covers the 1.75 MHz to 2.0 MHz frequency range and the other the 7.000 MHz to 7.425 MHz range. The VFO tank circuits and the output circuits are controlled by the front panel switch indicating the band of transmitter output. Temperature compensation, optimum circuit design, rigid construction, and voltage regulation result in a high order of stability. There is freedom from "wobulation" under modulation, or "yooping" when keyed. On the 160 meter and 80 meter bands the VFO output remains on the 160 meter tank. On the 40, 20, 15 and 10 meter bands the VFO changes to the 40 meter oscillator tank. On the 6 meter band, additional capacitors are

switched across this tank to lower the VFO frequency to a harmonic relation to the 6 meter band and add additional "C" to the oscillator to enhance stability.

A 6CL6 acts as an isolation stage and broad-tuned frequency multiplier when the VFO is used. During crystal oscillator operation, however, it functions as a hot cathode oscillator. Grid-block keying is employed for the oscillator, the 6CL6 isolation stage and an additional 6CL6 buffer-multiplier, utilizing a 12AU7 as the keying tube. This system is called "Timed Sequence Keying." To avoid adjacent channel interference, a wave-shaping filter is used in the 6CL6 circuits. To avoid chirp when the VFO is keyed, the 12AU7 permits the VFO to start before the 6CL6s conduct and continues oscillation until after the 6CL6s stop conducting. There is a VFO keyer adjust control which permits adjustment of the "hold" time in order to permit rapid CW break-in operation to suit the operator.

When operating break-in, a slight arcing at the key may be noticed in your receiver. This is not transmitted over the air, and may be eliminated by installing a 2-1/2 millihenry RF choke in each key lead right at the key. On the lower frequency bands, the RF stages are sufficiently broad as to permit a change of frequency within a CW or phone portion of a band by means of the VFO alone.

Obviously this would be more difficult on 10 and 6 due to the size of the bands. For greater excursions, the dial marked "exciter," final dip and loading will of course have to be touched up. Practice will quickly indicate the degree of latitude in this respect that you will have for the bands you use the most. A "spotting" switch position permits you to observe your transmitting frequency without unnecessary radiation on the air and to "zero" in on a transmitting station.

RF Circuit Operation

The 6CL6 stage used as a buffer-multiplier, mentioned earlier when the keying action was described, uses a tuned high Q plate circuit which is tuned to the same frequency as the final on all bands. Protection against excitation failure is derived from a cathode resistor. The band switch and coils are

fully shielded to avoid any possible interaction, ensuring clean circuit isolation and preventing instability. The output of this stage is controlled by a potentiometer which controls its screen voltage. This permits precision in adjusting the final grid drive. An additional multiplier stage, not present in the original Ranger, uses a type 5763 tube. It is switched in to drive the 6CL6 buffer-multiplier when operation is to be on 6 meters.

The final stage uses a 6146 with a pi-network of Hi Q design. The range of antenna impedances which may be matched on all bands is 50 to 500 ohms, plus the tuning out of a wide range of inductive or capacitive reactance. The range of antenna impedance which may be matched at frequencies above 7 MHz extends, roughly, from 25 to 2000 ohms. The 6146 is protected from excitation failure by a 6AQ5 which is connected in shunt with its screen dropping resistor. When excitation failure is encountered from any cause, the 6AQ5 conducts and lowers the 6146 screen potential to approximately plate current cutoff. The screen of the 6AQ5 clamper is connected to a voltage divider making the stage continue to conduct even at extremely low plate potential values. Under this cutoff condition the 35 to 40 mA current is indicated on the transmitter multimeter. It is not the plate current of the 6146 but is the plate current drawn by the clamper tube.

The Audio System

All triodes are employed in the speech and driver stages. The first and second amplifier is the high gain 12AX7, ample for any crystal or high impedance dynamic microphone. A three-circuit microphone jack is provided to accommodate the addition of a push-to-talk relay if PTT operation is desired. A 12AU7, parallel connected to a driver transformer, is the source of low impedance drive for the modulator. The modulator, employing a pair of 7027 tubes in push-pull class AB, can deliver more than enough audio for 100% amplitude modulation. Plate saturation limiting prevents large swings beyond full modulation, thereby providing some limiting to reduce distortion and spurious output. The modulation transformer has a tertiary feedback winding coupled to the grid of the audio power driver. This provides damping for improved regulation, stability and a flattened frequency response. This method also enhances the direct driving of external modulators when the Ranger II is used as an exciter.

The secondary of the modulation transformer is center-tapped to fill the

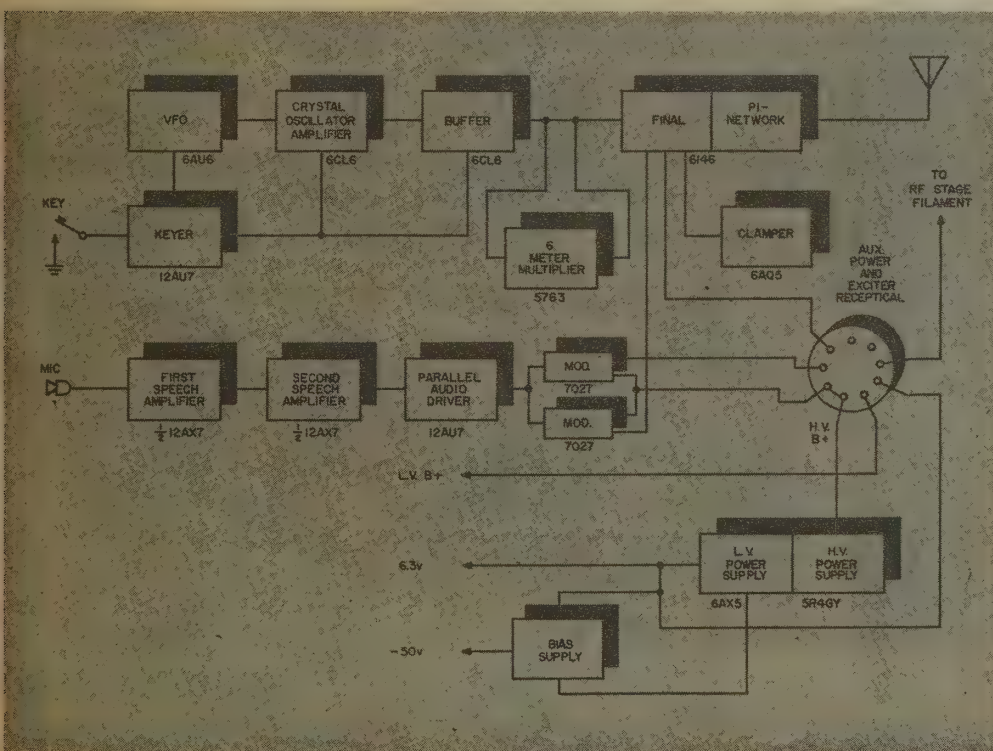


Figure 1. Block diagram of the Viking Ranger II.

requirements of an audio driver, permitting it to work directly into the grids of external high-power Class B modulators. The leads are filtered and bypassed, and made available at the exciter-auxiliary plug at the rear of the chassis. By using one half of the secondary winding, a nominal 500-600 ohm output can be obtained for driving large speakers used in paging or public address work. Thirty-three watts of audio are available at the output of the modulators for any application required. The frequency response range of the modulator section is flat within 3 dB from 250 to 3000 CPS with a very pronounced roll off above and below these frequencies. The passed range is sufficient for pleasing quality yet confines the audio power within these frequency limits for a noticeable audio punch.

The Power Supply

This is a conventional dual-plate voltage supply, employing a 5R4GY high voltage rectifier tube and a 6AX5GT low voltage rectifier. Choke input filtering is used in both supplies. The high voltage is 525 volts DC for the final and modulators, and the low voltage 320 for the RF exciter and low level speech stages. A 6AL5 rectifier for bias for the keying circuits and the modulator is fed from a third set of terminals on the power transformer secondary. If you want to power other equipment in the shack, you can use the rig as a power supply, from the exciter-auxiliary plug. In addition to the audio at this terminal, there is available 6.3 volts at 5.5 amperes for filaments, 300 VDC at

50 mA and 500 VDC at 210 mA. When the auxiliary plug is wired to tap off for external power, the complete RF section of the Ranger, including filaments, is de-energized, as the power supplies cannot provide the normal Ranger full power requirements and external power use simultaneously.

Operation

The E.F. Johnson Company did extensive research when amateur radio first faced the threats of TVI. This is reflected in minute detail throughout the Ranger II. The cabinet is electrically sealed with flexible monel braid on the inside of the front panel and large cabinet overlap. A cup-type shield seals the meter, and spring type contact washers on the front panel shafts prevent possible radiation from shaft clearance openings. The power line and relay jack circuits have double L-type filters; all auxiliary socket, meter, dial lamp, key, and meter lamp leads are equipped with L filter networks. To minimize harmonics, interior harness leads and filaments are bypassed to the chassis. Careful bypassing of the final and design of the output circuit were aimed at reducing harmonics. This deep interest in TVI led to the investigation of causes beyond the well-engineered transmitter. Improper grounding in the shack, as well as improper impedance matching, turned out to be another major source of trouble. This affliction troubles many an installation, regardless of the equipment, so if you are one who is being so deviled, beg, borrow, steal or buy a Viking Ranger II Operating Man-

ual. There are many common sense procedures within it which could be applied to your shack, both on the subject of TVI prevention and proper loading and matching of your antenna system.

One panel meter serves as a multimeter, providing ample indication of tuned circuit operation, switching between oscillator, buffer, grid, final plate and modulator. The manual tune-up instructions are a little confusing in that when told to tune the "buffer" your control is marked "exciter" on the panel. I would have preferred a slightly different turn-on, turn-off sequence in mode switching, but I guess you can't please everyone in every detail.

Putting the equipment on the air was revealing. I had a warmed-up BC-221 and a 75A4 ready to check calibration, but had little to do since the VFO dial marking fell right into the slots they were supposed to. The first firing up was late in the afternoon on 75 meters, with the initial CQ answered by a chap two states away who said his TX had been on 15

meters, but I sounded so good on 75 that he bust his buttons changing bands to call. Equally flattering remarks were produced on 6 and the other bands. With scope and panadapter on, the bug contacts were polished up, but no fault had shown up there either. The design and bugs on this equipment had been worked out so long ago that it might have been presumptuous to hope to dig up flaws thousands had been unable to find. The unsolicited flattering remarks were outstanding. I even tried to QRM my color TV receiver on 3.579545 MHz with no luck!

There is the Ranger II for you. It covers a whole lot of amateur bands in a day when many people specialize in just one of them. It gives you long- or short-range communications to fit any geographic requirement, environment, or skip, and is a good basic piece of equipment to use as a standard for measurement of other gear which you can be sure will be hard put to meet it.

Reprinted from the March 1962 issue of 73 Amateur Radio.

Specifications of the Viking Ranger II

Frequency Range:	160, 80, 40, 20, 15, 10 and 6 meter bands.
Power Input:	65 watts AM phone, 75 watts CW.
Power Requirements:	105-120 VAC, 50/60 cycles, 260 watts.
Frequency Control:	Integral VFO, or two switched crystal positions.
Utilization:	All-round portable or fixed transmitter, RF exciter, speech or power amplifier, or power supply source.
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the tech side

by Michael Jay Geier KB1UM

Roll Your Own

As a new ham, you probably are finding that talking to other hams is a great deal of fun. Most likely, you're meeting a whole community of new acquaintances and perhaps even making some real friends. And, of course, playing with that new HT is pretty cool. So, all seems right with your ham radio world.

Well, communicating with other hams is the whole point, right? Maybe, maybe not. After a few years go by, you may begin to get just a little bit bored with all that communicating. It's not uncommon for hams' interest to decline a bit after awhile. So, is ham radio ultimately pointless?

No way! Although talking certainly is fun, ham radio did not originate so that people could have lots of conversations. It began as a *technical* endeavor, and it continues to be one. Now, that doesn't mean you have to be a technology whiz to be a ham, or even that you should necessarily aspire to it. But, if all you ever do is buy gear and talk on it, you're missing at least half the fun. I can tell you from experience that nothing in this hobby beats the feeling of communicating on a piece of gear you built yourself. Nothing.

Can I Do It?

That's a little like asking, "Can I play the saxophone?" Maybe not yet, but you sure can *learn* to play the sax, even if you might not ever be Kenny G. You certainly can learn to build some

fun things, and you don't need to be a math genius or an engineer to do it. And the best part is, it doesn't have to cost much money, either.

What Can I Make?

You can build just about anything, but some things are much easier than others. I recommend that you start small. Today's radio equipment has become so sophisticated that duplicating the really fancy stuff at home is next to impossible. You aren't gonna make a Kenwood TS-850! But you may find it so much more fun to use the little 2 watt rig you built yourself that the '850 starts gathering dust.

New builders often think entirely in terms of making radios, either from kits or from scratch. Kits are fun, and they're a great way to learn the basics. Making actual transmitters and receivers (especially those) from scratch, though, is quite a bit more complicated than some other useful things you can whip up. Like what? Like keyers, microphones, speaker-mikes for HTs, power supplies, amplified speakers, antenna tuners, packet modems, switchboxes, you name it. And you don't have to start from ground zero, either; tailoring and modifying existing equipment to match your needs is very rewarding, too. In fact, one of my favorite uses for home-brewing (as we like to call the home building of equipment) is for custom stuff I just can't buy.

For example, I like to use a headset with my walkie, especially at hamfests. Yes, I can buy one.

It ain't cheap, though, and it's really much bigger and bulkier than I'd like. Also, it doesn't come with a PTT (push-to-talk) switch, because it's designed for use with the VOX (voice-operated transmit switch) circuit built into the walkie. I find, though, that VOX operation at hamfests is very awkward, because every time I ask somebody a price or something it goes out over the air! So, I never bought the factory-built headset.

Treasure Hunting

What I did do, though, was keep my eye out at hamfests for something I could make into the headset I really wanted to own. It took awhile but, one day, there it was: a miniature telephone headset with a tiny boom mike tube. You know, the kind the operators in all those late-night TV infomercials wear. I think I paid five dollars for it. Well, all I had to do was wire up a new plug for it, add a PTT switch and I was all set.

... NO!!

It didn't work. I could hear fine, but when I tried to transmit, the audio was so low it was useless. What was going on here? A little detective work with my trusty ohmmeter showed that this thing had a dynamic microphone in it. Unfortunately, all modern walkies use condenser mikes, which put out a *whole* lot more signal than the old dynamics. At this point, you might think that I'd wasted my five bucks and wound up chucking the headset into a drawer. Nope! I did what any self-respecting home-brewer would do: I cracked the case open and replaced the mike with a condenser mike I got. I think, at Radio Shack. OK, so it doesn't look like a factory job anymore, what with the glued-together plastic and all. But it *works*. In fact, it works great. And, every time I use it at a hamfest, at least three people come up to me begging to know how I did it, where I got it, and how they can get one, too. Now that's fun!

Another great example is the dead 2 meter walkie I got for two dollars at yet another recent hamfest. I figured at a buck a meter it was a good deal! Naturally, it didn't even come close to work-

ing, but I managed to fix it. When I got done, though, I discovered that the thing wouldn't work on 13.8 volts, which is the only DC supply I have in my station. The radio was designed to work on 9 volts, and the extra voltage was sure to destroy it. Hmmmm... wait a minute, didn't I get a DC regulator pack for a Sony camcorder for a buck at the last 'fest? It took a bit of digging, but I found it. But it put out 8 volts, not 9. So, I opened it up to see if there was a way to adjust it. I saw a trimpot (small potentiometer) inside and, sure enough, that set the output voltage. I adjusted it for 9 volts and closed it up. My "new" dedicated packet rig, which cost all of three bucks and looks like hell, works like a charm. And, to top it all off, every time I operate packet I think of it and feel terrific.

Nothing's Perfect

One thing I've learned from all my years of fooling around with stuff like this is that nothing is ever ideal. When you try to marry any two unrelated devices, some of the details won't match. The voltage will be wrong, or the plug will be wired with opposite polarity. Or the thing will *almost* fit into the case like you'd like it to, but not quite. Rather than get frustrated, though, consider these things as challenges to your creativity. Find a way to make it work. Cut a little here, trim there, adjust, repack, bend the circumstances to your desires. When you got it working, it really feels great knowing you have the only one like it in the world!

How Do I Start?

First, take a look around at your station and ask yourself what you would like to have. If it's a new, digitally synthesized HF rig, start saving! But, if it's a Morse code keyer, a charging stand for your walkie, a way to use the same desk mike on more than one rig without plugging cables, or something like that, start thinking!

As I mentioned, hamfests are great places to pick up all kinds of "junk" that you can turn into things you want. I can't count the number of times I've enhanced my station in exactly that

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way. Also, I've noticed that most people go for the same perfect-condition, expensive items at hamfests, passing up the modifiable gems. Consequently, the prices for these bits and pieces often are quite low: the seller just wants to get rid of them. Heck, a few times I've even gotten useful stuff for *free*, just because the seller didn't want to cart it home.

If there's no hamfest coming up any time soon, don't get discouraged. Take a look at what you already have lying around, and you might be surprised at the new ideas it can inspire. You can make several nice things from an old cassette recorder, including a speaker-mike, a switchbox, and even an amplifier for your HT's audio.

But I Don't Know How

Nobody is born knowing how to build, fix or modify electronic equipment! We all had to start somewhere, and, no matter how skilled we get, we're all still learning. Pick something simple and research the information you need to get it to work. Go to the library, order the schematic

or find somebody on packet who has it, get some books on basic electronics. If you have questions, get on the air and ask around. You won't be looked down upon for not knowing everything. In fact, you'll probably be admired for getting into the technical side of the hobby. These days, technical hams are in the minority and are held in high esteem. Just trying to become one will put you in a very positive light.

Bear in mind that, if you are connecting your project to something expensive like your HT, you don't want to cause any damage. Naturally, trouble is more likely if you're making up a power supply than if you're creating a headset, so I recommend you don't try anything potentially disastrous for your first project; nothing will turn you off faster than the sight of smoke from your \$350 radio!

Some Ideas

For many hams, antennas are the be-all and end-all of homebrewing. Commercial antennas are rather expensive, and it doesn't take any knowledge of transistors, ICs or schematics to make a good antenna. If you want a sophisticated beam antenna, though, you may find that the effort and expense of rolling your own are overwhelming. But why not try making a simple wire antenna? Dipoles, loops, slopers and such are pretty easy to build, and you can make something every bit as good as a commercial \$75 skyhook for around \$5 to \$10.

Switchboxes which let you route the audio inputs and outputs of your radios are very handy, and you can't buy them. For instance, if you run packet radio, how about a switchbox that simultaneously switches the mike and speaker connections to your TNC (terminal node controller) or modem? That way, you won't have to listen to that awful packet screech. If you really want to get fancy, you can cook up an automatic switch that hooks you up for packet whenever you turn the TNC on and switches back to voice when it's off.

If you use your HT in the car, how about a nice speaker mike? Sure, you can buy one, but it'll cost you at least \$20, probably more, and you can make one from an old mike, or even from scratch, for next to nothing. Or, perhaps you could use an amplified speaker so you can hear the darned thing at 55 mph. You can even modify one of those cassette adapters made for portable CD players so that you can listen to your rig through the car stereo! How can you beat that?

I'm sure you'll think up some more neat gadgets. If you can envision it, chances are you can build it! And I promise that the feeling of pride you'll get when you use it will be one of your favorite experiences in ham radio.

Until next time, 73 from your home-brewin' friend, KB1UM.

RF

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radio magic

by Michael Bryce WB8VGE

Repairs, Via the Junk Box

It's great to have a large junk box to dig into when the oscilloscope dies. That's exactly what I did and ended up finding a somewhat usable power transistor.

The transistor I found happened to be a generic TIP-42. Electrically speaking, this transistor would be an ideal replacement, but it wouldn't fit the Heath PC board. It seems Heath always had a way with using non-standard parts. Or maybe it was the other way around, using non-standard parts to make the PC board layout easier. Who knows?

But, to check out the operation of the scope and to verify my repair, I had to snake the leads of the new transistor into the holes of the PC board. This worked just fine, until I noticed the transistor wouldn't fit the heat sink. The heat sink is connected electrically to the case of the transistor. I could not use the existing heat sink on the replacement transistor; it would short out the very circuit I was trying to repair.

My junk box goody was way too small for the job. The old heat sink was made of extruded aluminum and looked like it could really take the heat. Unfortunately, the junk box special would not take as much heat. So, after several minutes, the new part would just up and quit.

Sometimes, the best fix requires the proper part. But, in my case, the equipment was so old that I couldn't find the proper part. To make matters even worse, the transistor had a Heathkit part number. Heathkit is no longer in business so I couldn't get the transistor from them. Lucky for me, the Heath manual has a commercial part number listed. But, that part is also no longer being made. It didn't look like this story was going to have a happy ending.

But wait! As Mr. Spock would say, "There's always possibilities." The most likely possibility to save me was NTE replacement transistors. NTE has just about everything under the sun. NTE had the part I needed, so, I ordered one from Mouser Electronics. In a few days the scope was working just fine on my test bench.

If you're like me you're still wondering what made the silly thing up and quit in the first place. This is a question I have to answer each and every time I do a repair job. Like everything in life, nothing is perfect, including transistors. It's generally known in the consumer electronics industry that if a part is going to fail, it will happen within the first three months of service. That's one of the reasons why just about everything electronic comes with a 90-day warranty. After 90 days, it's a good bet you'll never have any problems. This is why stores make out by selling extended warranties.

What makes an electronic part fail? Well, perhaps the number one reason is heat. Since any solid-state device is a semiconductor, it's not a perfect conductor of electricity. When an electrical current passes through a transistor junction, heat is produced. The heat generated is measured as watts. The amount of current flowing and the type of device will have an overall affect on the amount of heat generated. There are many, many other specifications that must be taken into account when doing design work, but we'll pass on them right now. It's enough to know that transistors (and ICs) do get hot. The bottom line is, *They're suppose to*. However, too much heat and whoa! You'll be scanning Mouser's catalog looking for a replacement part.

Reducing Heat

Most bipolar transistors can easily be destroyed by thermal runaway. Thermal runaway occurs as the transistor gets hot. As the transistor gets hotter, it produces more heat. The more heat it produces, the less efficient it is, thus generating more heat. The cycle continues until the transistor goes belly up. Unless you can keep the device cool, the whole process can take only a few seconds!

This is exactly what happened (I think) to my scope. To prevent thermal runaway, we should design our circuits so they run cool. If you can't do that, then the use of a heat sink is a must. A heat sink moves the heat from the junction inside the transistor to the surrounding environment. Heat sinks are some-

times called *coolers*, too. The high-speed CPU chips used in most of today's computers generate so much heat they require a special chip cooler to reduce their temperature. Sometimes a micro-sized fan is also attached to these chip coolers to improve their cooling properties.

One of the first electrical laws you may have encountered is good ol' Mr. Ohm. We'll put him to work as we do some simple math. Let's break out the calculator and do some number crunching.

The circuit shown in Figure 1 does nothing. It's only to show you the what and why as we punch in some numbers. Just for the sake of argument, let's say it's the deflection circuit from my scope. Let's begin.

From R31, we have 280 volts DC on the emitter and 150 volts DC coming from the collector. The base drive for this transistor comes from R93. So, let's see how hot this transistor will get. The transistor is supplying 55 mA of current to the deflection plates.

First, we'll subtract the 150 volts from the 280, getting 130 volts. That's the voltage drop across the transistor. We'll call this guy E for voltage (don't ask me why). Now, since we know the current is 55 mA, we can use the formula: power as watts equals current (I) times voltage (E). So, 130 times 0.055 = watts. Punch in the numbers and we get 7.15 watts. That's not bad and I can live with that knowing the heat produced will be dissipated by the heat sink mounted to the transistor.

But what happens when we start to pull too much current? Let's find out. Let's say the circuit is now pulling 230 mA. Again punch in the numbers and you'll find out the transistor must get rid of almost 30 watts! My soldering iron uses only 18 watts. In no time at all, the transistor would be toast and you'd have a repair job on your hands. Of course, after you replace the transistor, you'd better find out why you have 230 mA flowing instead of 55 mA!

Now let's look at the same circuit, but with a different twist. This time we'll be building a power supply to operate your rig. You'll need at least 20 amps at 13.8 volts. Let's say the project came from an issue of *73 Amateur Radio Today* and looks like it might be just what you're looking for.

In the article, it calls for a transformer with an 18 volt secondary. Well, you don't have one, but you do have a 24 volt job laying in your junk box. It would be a dandy for this project, or would it?

The project calls for a bridge diode and capacitor input, very common in power supplies. But by using this, you'll raise the voltage of your transformer slightly. The voltage is increased by 1.4 times the secondary voltage of your transformer, so 24 volts times 1.4 equals 34 volts. Your rig only needs 1.5 amps on receive, and the transformer can do 35 amps, so you're one happy camper, or are you? Since we only need 13.8 volts, the pass transistor has to get rid of the excess voltage. Let's do some number crunching to see what's happening. With 34 volts on one side of the transistor and 13.8 on the other we have a voltage drop of 20 volts. Since we're drawing 1.5 amps from the supply we are dissipating 30 watts of heat. Ouch! But wait, it gets worse. Key your rig and you're now pulling 20 amps. The power now being dissipated is 400 watts! That's 20 volts times 20 amps.

This is just to show you how you can use some simple math to help design your own gear. Of course, you would never use only one transistor in the above example, but for clarity I did. Please, no *Hate Mike* letters on this one.

There's no need to be a rocket scientist to have fun with ham radio, but there's nothing wrong with knowing a little about what's going on deep inside those shiny gray boxes.

RF

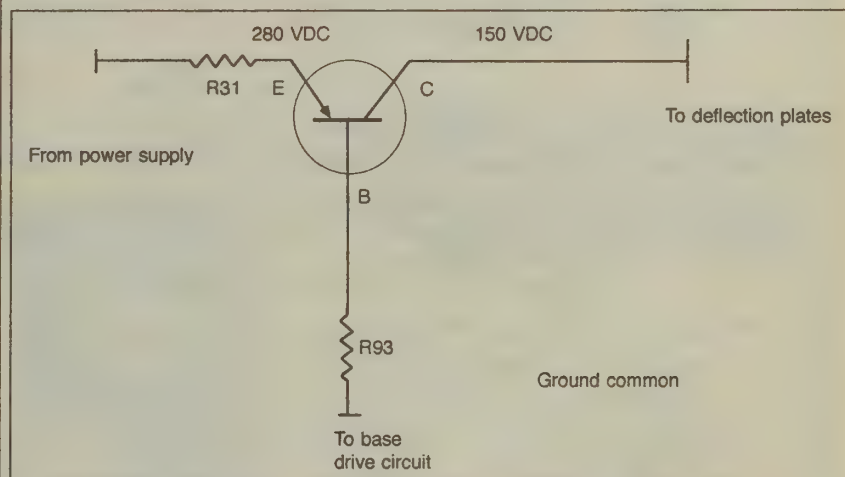


Figure 1. A theoretical transistor circuit.

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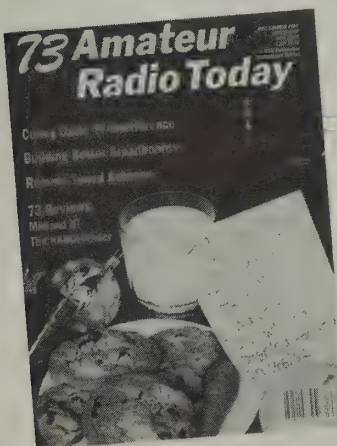
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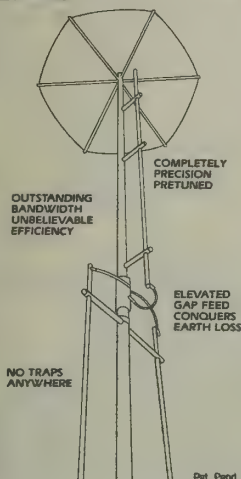
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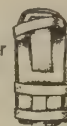
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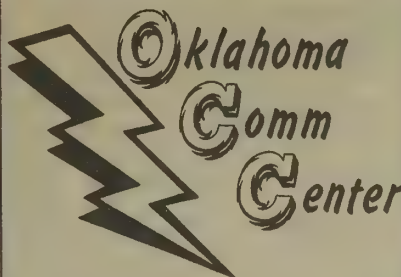
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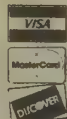


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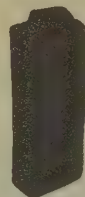
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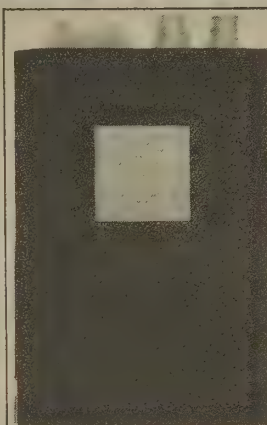
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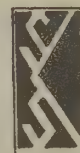
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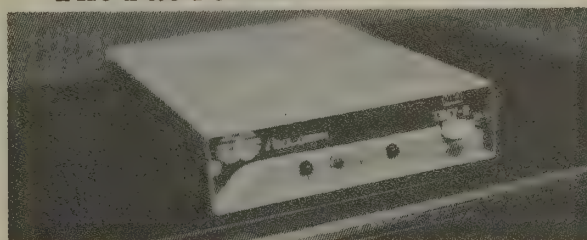
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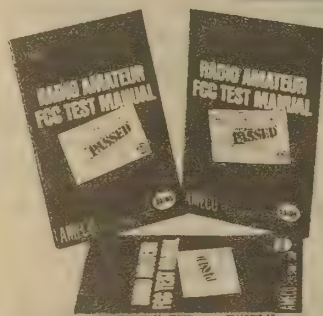
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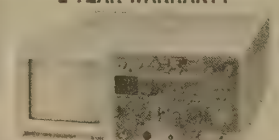
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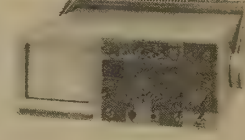
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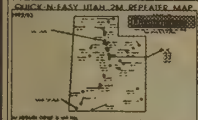
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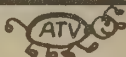
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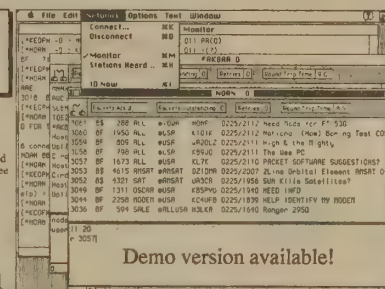
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Joe Carr

**antennas,
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by Joseph J. Carr K4IPV

A Home-Brew Antenna Impedance Bridge

Antenna impedance is one of those things that we sometimes like to measure when working on antennas. One good reason is to provide an impedance match between transmitters, transmission lines and antennas. There is an electrical circuit axiom that the maximum power transfer occurs when the output impedance of an RF source is matched to the load impedance (i.e. the feed point impedance of the antenna). When we measure standing wave ratio (SWR or VSWR), we are implicitly measuring how well the load impedance matches the source impedance. When the load impedance presented by the antenna matches the coaxial cable impedance and the transmitter output impedance, the VSWR is 1:1. In this column, we will take a look at a simple antenna impedance meter that you can build.

The Basic Bridge

Figure 1 shows the basic bridge circuit.

This particular circuit is called the Wheatstone bridge and, while different from the bridge we will show shortly, it serves to illustrate the operation. In the bridge circuit, a detector (microammeter, radio receiver, etc.) is placed to read the difference in voltage between the outputs of two voltage dividers. Point "B" is the output of voltage divider Z1/Z2, while point "D" is the output of voltage divider Z3/Z4. When the ratios $Z1/Z2 = Z3/Z4$, the voltage drops are identical, so the detector sees zero signal level; this is called the null condition. In most RF impedance bridges, either a variable resistance or a variable reactance element (e.g. variable capacitor) is fitted with a dial that is calibrated in ohms. In those bridges, one of the other impedance elements will be the antenna impedance.

Figure 2 shows the basic (but simplified) circuit for an RF bridge. Signal is applied through a trifilar-wound toroidal transformer (T1), while the impedance bridge elements consist of the antenna impedance (ZX), fixed resistor R, and a

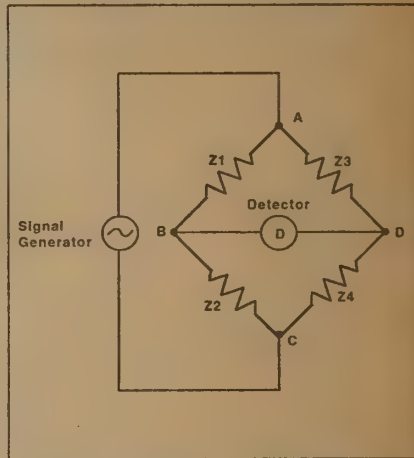


Figure 1. Wheatstone bridge circuit.

two-section differential capacitor. The "diffy cap" is an air variable capacitor with two sections on the same shaft, but connected such that while one is increasing in capacitance the other is decreasing in capacitance by exactly the same amount. These capacitors are sometimes a tad difficult to obtain, but I've seen them in the catalogs of Radio Parts (Pelham, NH) and Ocean State Electronics (P.O. Box 1458, Westerly, RI 02891; 1-(800)-866-6626 for orders, (401)-596-3080 for information or catalog requests).

The complete circuit for the antenna impedance bridge is shown in Figure 3. In this version, the signal source is external, and is brought into the instrument through an SO-239 chassis-mounted connector (J1). On reflection, I would probably use a BNC connector for this purpose if I built another copy.

Because there is an input amplifier (Q1/Q2), you can drive this bridge with an ordinary RF signal generator. The transistors used in the amplifier can be any NPN devices with gain through the lower VHF region. I used NTE-161 devices (Ocean State carries these replacement line transistors) because they were easily available from my junk box.

The output of the two-stage amplifier is fed to the bridge through a trifilar-wound transformer (T1). The toroidal core can be either a T-50-2 (RED) or T-50-6 (YELLOW) from either Amidon Associates or Ocean State. The toroidal core is wound with 12 turns of #26 or smaller enameled wire. "Trifilar" means that all three windings are wound together. One of the easiest ways to do this type of winding is to twist the three wires together (five to nine twists per inch). I use an electric drill with a speed control (slow!!!) to twist the wires. One end of the three wire bundle is anchored in a bench vise, while the other end is chucked up in the drill. The drill is operated on the slowest speed until the desired twist is achieved. NOTE: This can be dangerous to the eyes, so wear safety glasses, goggles or a face

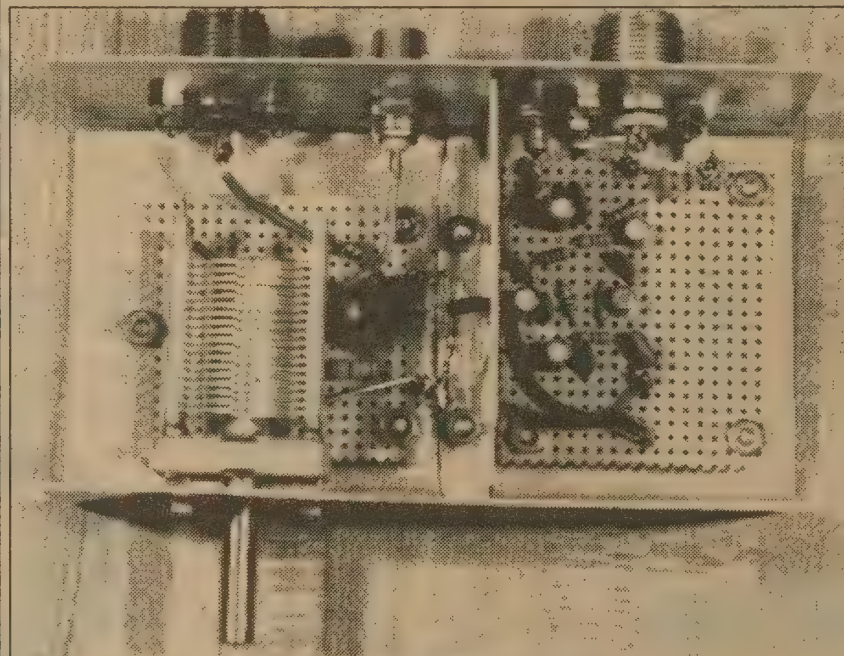


Photo A. Actual project as built.

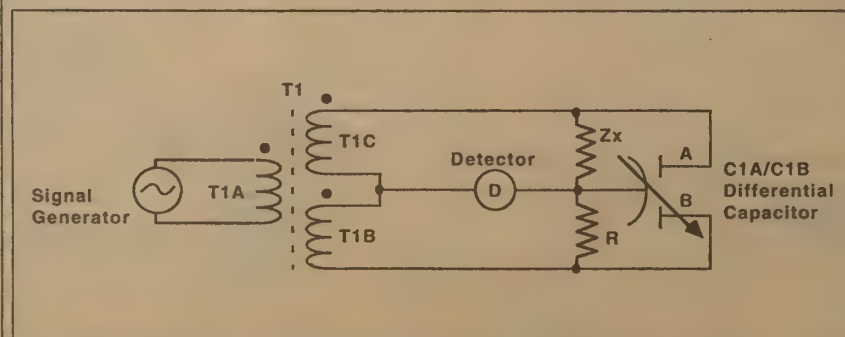


Figure 2. Basic RF bridge circuit.

shield when doing this operation. Also, be careful not to get snagged in the wire—it can injure you (which is one reason for proceeding on the slowest speed setting).

The antenna impedance is the unknown impedance, and it is connected to the bridge through J3, which is an SO-239 chassis-mounted connector. The resistive element is R1. If you intend to operate only at 50 ohms, then replace R1 with either two 100 ohm resistors in parallel or a single 51 ohm resistor. The value 68 ohms is a reasonable compromise between 50 ohm and 75 ohm systems.

The differential capacitor is a 2 X 150 pF unit, and is mounted so that the common rotor plates are grounded. Sections A and B are connected to the unknown

impedance (J3) and the fixed impedance (R1), respectively.

The detector for this impedance bridge is a radio receiver. The detector signal is brought to the outside world through a BNC jack (J2), where it is connected to the receiver antenna input connector through a short length of coaxial cable.

The two sections of the antenna impedance bridge are the amplifier and the bridge. Note in Figure 3 that each section is shielded from each other and from the outside world. Signal is passed from the output of the amplifier (Q2) to one winding of transformer T1 through a small hole in the shielding partition between the sections.

Photo A shows the antenna impedance

bridge as built. The instrument is assembled inside of a small aluminum chassis box. Be sure to use only those boxes that have a quarter-inch (or so) overlapping flange between the halves of the box. The cheapies that use a little dimple or pinch on one halfshell are not suitable for RF work (they leak too much signal). Also, make sure that the unit is a high quality model (Bud, LMB or Hammond are examples). Shun boxes, even with overlapping flanges, that seem distorted in shape, or where the halves are ill-fitting. They leak RF like a sieve.

The bridge was eventually fitted with a vernier dial. These dials (Ocean State order number VD-112-100 or VD-2) will drive quarter-inch shafts found on vari-

able capacitors, and are calibrated 0-100 on an 8:1 vernier multirun mechanism. A calibration chart can be made by using noninductive carbon composition resistors. I used 10 ohms, 33 ohms, 50 ohms, 75 ohms, 100 ohms and 200 ohms. The 50, 100 and 200 ohm resistances were made from the same 100 ohm carbon resistors. It is important to know the actual (not nominal) resistance of the calibration units. I used a digital multimeter ohmmeter scale to sort 10, 33, 75 and 100 ohm resistors to find those that are closest to the selected value.

The antenna impedance bridge is a relatively sophisticated project, but is well within the capabilities of most beginners. **RF**

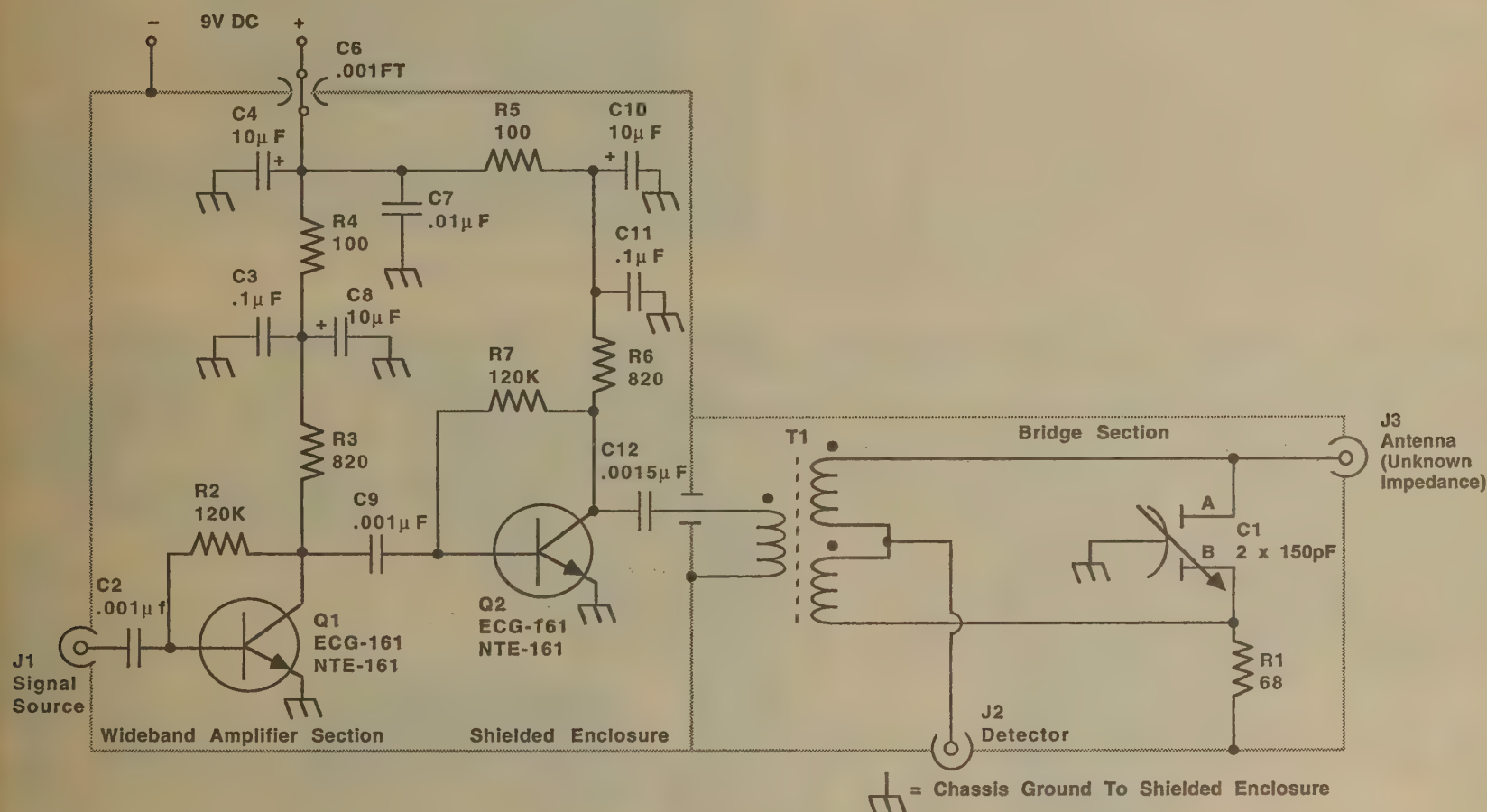


Figure 3. Complete project circuit.

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by Gordon West WB6NOA

Phantom Signals Around the House

A very strange thing may occur for the first time among new amateur radio operators inside the house—phantom unmodulated signals coming in on your new 2 meter transceiver. Maybe it's a steady carrier that always seems to be there, just a few channels away from your local repeater. Or maybe you are hearing a swishing sound that cycles between 146.820 all the way up to 147.500 MHz.

"Everybody calls my house the two-tone generator," comments Margaret Foster N6GLF. "All of our local simplex operations are on 146.520 MHz, and all around my house all anyone can pick up are these two tones that cycle back and forth. No one can figure it out," adds Foster.

These phantom signals coming from your house can be so strong that they might cover up your local repeater channel. Or maybe they're just a nuisance on the repeater channel, keeping your squelch open to these annoying sounds even though the repeater frequency is not in use. No matter how hard you crank your squelch circuit up, the annoying whistles, tones, or steady carriers continue to beam into your 2 meter transceiver.

It gets worse for those 2 meter operators who work single sideband and CW through the orbiting satellites, or operate SSB and CW for long-range tropo contacts. These extra-sensitive receivers, operating on SSB and CW, are rendered useless on specific operating frequencies that this phantom tone or carrier shows up on. And it's quite common to find this phantom carrier slowly sliding up or down the frequency at different times of day.

So where's it all coming from? Here's the list:

- Home computer.
- Facsimile machine.
- Home telephones with memory dial.
- Microprocessor-based heater and air conditioner controls.
- Ultrasonic bug repellers.
- Cable television box.
- Microprocessor-based fish-tank heater.
- "Smart" electric blankets.
- Talking calculators.
- Programmable scanners turned on.

If it's got a computer chip on the inside,

it's going to be a phantom signal generator. These devices are characterized by the Federal Communications Commission under Part 15 as "unintentional radiators," and by law must not emit spurious signals more than a few feet away from their inside microprocessors.

Finding the Culprit

To resolve the problem, you first must figure out exactly which piece of home electronics is giving off these mysterious signals. This requires you to put the little rubber antenna on your 2 meter handheld and dial up any frequency where this phantom noise is received weakly. Now start walking around, room by room, listening to the incoming phantom signal and watching the little LCD bar graph on your handheld that may be steadily getting higher and higher. This means you're getting closer and closer!

When you get to the point where your LCD S-meter won't go any higher, look around and see what home electronic device you are standing next to. Now remove your hand-held antenna, turn the squelch off, and hold the handheld right next to that device. When you are within two or three inches from the noise-maker, the signal will begin to appear on the handheld without an antenna, and chances are you have found the culprit.

Now lay your handheld on top of the device, and then unplug the device from the wall. Does the noise go away? It probably will. If so, this is the device that's radiating the noise that gets into your 2 meter system.

Now put the antenna back on, then scan the entire 2 meter band to see if there are any other devices in your house creating the racket. If you have only one (which you have already unplugged), you are lucky. Here at Radio School, I have seven different machines that give me phantom signals on seven different frequencies on the 2 meter band!

Solving the Problem

Getting rid of the problem is sometimes as simple as moving the device a few feet from its original position and wrapping up the excess power cord into a tight circle to act as an RF choke. Most of the time, the noise comes directly from the equipment to your antenna on the roof. Filters on the device normally won't help.

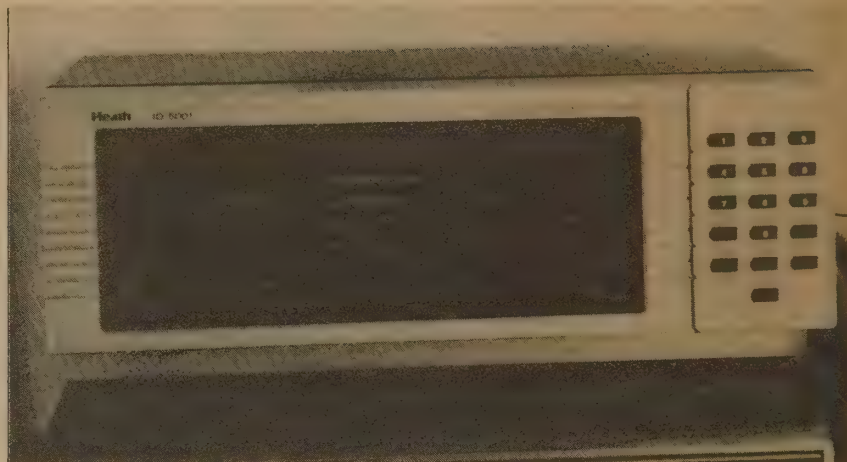


Photo B. This weather station kit gave us a strong signal on 146.940. Unplugging the weather station made the signal disappear instantly.

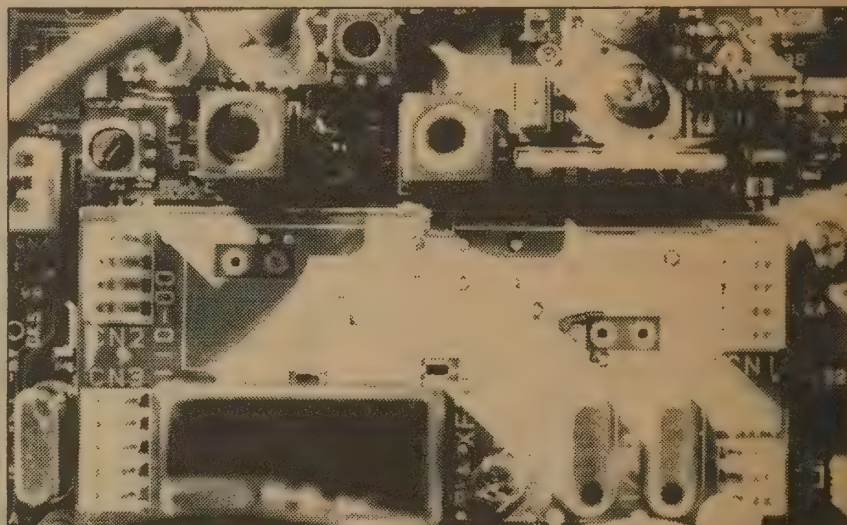


Photo C. The crystal circuits in this unit (bottom portion of the board) are not in a shielded container and may give off phantom signals on 2 meters.

Sometimes aluminum foil right below the feet of the equipment will make things better—but sometimes it makes things worse. You just have to listen and play around with the equipment while listening to your receiver.

In worse-case scenarios, such as a device that is putting out a phantom signal right in the middle of the satellite band, you may need to replace it with another type of device which has the signal some-

where else. If you are technical, you may sometimes go into the master clock circuitry and ever so slightly tweak the trimmer cap to get the phantom signal to go somewhere else. Once you locate the tiny crystal, gently moving it a little bit to the left or right on its pins will change the capacitance just enough to swing the signal completely out of the band. But this requires taking apart the equipment, and you'd better know what you are doing before you launch this effort.

So tune around your house and see what things are putting out phantom signals. If you know where the signals are on the dial, you can avoid a lot of frustration in trying to figure out where NOT to operate. And if the phantom signal is right on a particular frequency that you love, start to work on the home electronic device and see what you can do to kick this signal off of your favorite channel.

RF



Photo A. The LCD bar graph of signal strength indicates the phantom signal is close to these handhelds.



what's next?

by Carole Perry WB2MGP

Space Grants for Education

Followers of my columns are well aware of the high value I place on incorporating space travel and communications lessons in my curriculum for my sixth-, seventh- and eighth-grade ham radio classes. There's always something new going on in the space program, and the chances of making live contacts with the astronauts get better all the time, thanks to the SAREX program.

I try to attend as many as possible of the NASA workshops that are given in my school district. Whenever you attend one of these NASA educational workshops, you can count on leaving with tons of printed material and at least four or five new ideas for highly motivational lessons to use in the classroom. Almost all the material can be modified to fit a particular ability and age group. You can also benefit by keeping updated on the grants that are available through the NASA workshops.

The National Space Grant College and

Fellowship Program is a nationwide network of consortia that addresses math, science, technology and engineering education throughout the educational spectrum. The Virginia Space Grant Consortium (VSGC) programs use space and technology themes to create an exciting educational environment for students and teachers. Like most NASA-related educational programs, the aim is to produce scientifically literate students who will be the workers and engineers of the future.

The VSGC's programs provide a broad mix of practical research, hands-on experience, teacher professional development, student activities, classroom resources and research enhancement. Some highlights of these programs are:

1. Student Activities: "Young Astronaut Camp-Ins" developed by the Consortium's two museums, the Science Museum of Virginia and the Virginia Air and Space Center, gave nearly 300 Young Astronaut Club members an overnight science enrichment program

combining field trips, science and camping. The Colorado Student Ozone Atmospheric Rocket (CSOAR), a project of NASA and the Colorado Space Grant Consortium, with support from the VSGC, was a hands-on experience in the design, building, and successful launching of a NASA sounding rocket payload for more than 80 engineering, physics, and journalism undergraduates. A follow-on partnership with the Colorado consortium will re-fly the payload while giving real-world engineering experience to other students in the two states. These two sounding rocket projects are among the partnerships that Virginia has formed with other Space Grant Consortia across the country. The VSGC is currently partnered with state consortia in Connecticut, Delaware, Pennsylvania, West Virginia, Maryland, and the District of Columbia.

2. Television Production: The consortium's educational programs have made extensive use of its members' broadcast and audio-visual resources. "Reaching for the Stars," a five-part, live videoconference series broadcast nationwide this past winter and spring, presented Space-Grant-supported scholars and fellows at five Virginia universities as role models for middle and high school students to emulate. The students taught science lessons, based on their research, which were keyed to the middle and high school curriculum. Currently in the planning stages is "Mission: EarthBound," a series of national broadcasts for teachers and students in grades four through eight which will introduce problem-based learning as applied to earth systems science. The consortium co-producers are NASA and Old Dominion University.

3. Teacher Training Workshops: In collaboration with the Department of Energy's Continuous Electron Beam Accelerator Facility (CEBAF), the consortium developed the Summer Institute for Teacher Enhancement. Teachers were involved in real-world research and acquired the skills to structure similar research activities for their students. School counselors received the consortium's booklet "Counseling our Future Work Force," which details roadblocks that girls and minorities face in science and math.

4. Undergraduate Scholarships and Graduate Fellowships: Each year the VSGC awards at least \$151,000 in Space Grant scholarships and fellowships at the five Virginia Space Grant Colleges. Since 1989, these awards have encouraged 56 students to pursue degrees in the sciences, mathematics and engineering. Students engage in real-world investigations with world-class researchers at Virginia universities and other cutting-edge centers like the NASA Langley Research Center and the Harvard-Smithsonian Center for Astrophysics.

For further information about the exciting programs of the VSGC, write to: Virginia Space Grant Consortium, 2713-D Magruder Boulevard, Hampton VA 23666.

Most good teachers consider it to be their professional responsibility to attend educational workshops which will enhance their teaching techniques and increase their curriculum knowledge. It is my recommendation that no matter what grade level you work with, you should attend at least one NASA educational workshop in your area every year.

RE



Photo A. Seventh-grader Robert shares his Space Camp experiences with the class.



Photo B. Sixth-grader Peter Kim builds a model space shuttle and does reports on space travel.

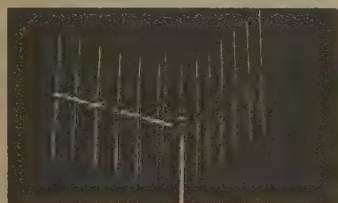


Photo C. Seventh-grader Jessica created crossword puzzles from space travel lessons.



Photo D. Sixth-grader Dean builds a Leggo launch pad for his space project.

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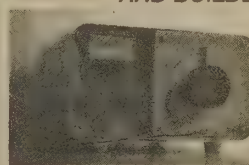
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The *Radio Fun Flea Market* costs you peanuts (almost)—comes to 25 cents a word for individual (noncommercial) ads, and 80 cents a word for commercial ads. Don't plan on telling a long story. Use abbreviations, cram it in. But be honest. There are plenty of hams who love to fix things, so if it doesn't work, say so.

Make your list, count the words, including your call, address and phone number. Include a check or your credit card number and expiration. If you're placing a commercial ad, include an additional phone number, separate from your ad. This is a monthly magazine, not a daily newspaper, so figure a couple of months before the action starts; then be prepared. If you get too many calls, you priced it too low. If you don't get many calls, too high.

So get busy. Blow the dust off, check everything out, make sure it still works right, and maybe you can help make a ham newcomer or retired old-timer happy with that rig you're not using.

Send your ads and payment to *Radio Fun Flea Market*, Judy Walker, 70 Route 202 N, Peterborough NH 03458, and get set for the phone calls.

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activities calendar

Send your announcements to: *Radio Fun Activities Calendar*, 70 Route 202-N, Peterborough NH 03458. We'll print as many as space allows, on a "first come-first listed" basis.

JAN 8-9

FT. MYERS, FL A Hamfest will be held by the Fort Myers ARC, Inc., Sat. 9 AM-5 PM; Sun. 9 AM-3 PM., at Araba Shrine Temple Hall, 2010 Hanson St., (One block East of Rt. US 41). VE Exams Sat. at 1:30 PM; Sun. at 10:30 AM (no pre-registration required). Talk-in on 147.345-MHz. Contact: Jerry Deutscher K4UW, (813) 472-5130; Dale Hardin K4UAO, (813) 275-8360; or G.E. Sammons WA4DQE, (813) 936-1431.

JAN 15

HAMMOND, LA The 1994 Hammond Hamfest, sponsored by the South-east Louisiana ARC, will be held from 9 AM-3 PM in the SLU University Center. Talk-in on 147.00/146.52 simplex. Contact Tyrone Burns, (504) 294-5839; or Bob Prieze, (504) 542-1470; or write to SLARC, P.O. Box 1324, Hammond LA 70404.

MONTEREY, CA The Naval Postgraduate School ARC will hold its 5th annual Hamfest from 8 AM-1 PM+ at the Monterey Peninsula College Armory. Talk-in on 146.97-. Contact: Doug KC3RL, (408) 663-6117 evenings; Pat KA6IRS, (408) 649-4444 Ext 20, weekdays.

ST. JOSEPH, MO The 4th annual Northwest Missouri Winter Hamfest will be co-sponsored by the Missouri Valley ARC, Green-Hills ARC and Ray-Clay ARC. The event will be held at the Ramada Inn from 9 AM-4 PM. VE Exams. Talk-in on 146.85 and 444.925. For Dealer info, write to Northwest Missouri Winter Hamfest, P.O. Box 182, Cameron MO 64429.

JAN 16

MATTAPOISETT, MA An Electronic Flea Market will be held at Knights of Columbus Hall. For more details call (508) 993-3993.

YONKERS, NY The Metro 70 cm Network will host a Giant Electronic Flea Market at Lincoln H.S., Kneeland Ave., 9 AM-3 PM. VE Exams. Talk-in on 440.425 MHz; pl 156.7; 223.760 MHz; pl 67.0; 146.310 MHz; 443.350 MHz; pl 156.7. For registration, call Ono S1upliska WB2SLQ, (914) 969-1053.

JAN 22

FLINT, MI The 2nd annual Computer and Amateur Radio SWAP-N-SHOP, co-sponsored by ARAY and SW Academy RC, will be held from 8 AM-1 PM at S.W. Academy H.S., 1-69 & Hammerberg Rd. Walk-in ARRL VE Exams at 9 AM. Talk-in on 145.29-, 224.18-, and 224.14-. To reserve tables, call Keith N8QNA, (313) 635-4123.

LOVELAND, CO The Northern Colorado ARC will host the 1st annual Winterfest Swapmeet from 9 AM-3 PM, at the Larimer County Fairgrounds, 700 Railroad Ave. VE Exams. Computer and Radio. For VE Exams contact Trent Hays WB0HZZL, (303) 484-8315. For general info, contact Musser Moore AA0PB, (303) 221-3698. Reserve tables from Orin Jenkins K00J, (303) 353-7094. Talk-in on 145.115 (-offset, 100 Hz).

JAN 23

EAST LANCASTER, PA The Columbia Area ARC will present its annual "Dutch Country Computer and Communications Show" from 9 AM-3 PM at the Lancaster Host Resort and Conference Center. Route 30. Talk-in on 146.715-. For display and dealer info, contact Dutch Country Computer and Communications Show, P.O. Box 682, E. Petersburg PA 17520-0682. Tel. (717) 560-2072; FAX (717) 872-0857.

JAN 29

LOCKPORT, NY The Lockport ARC will hold their annual Club Auction starting at 3 PM. Talk-in on 146.820-MHz.

SARASOTA, FL The Sarasota Co. Fairgrounds, 3000 Ringling Blvd., will be the location for the Sarasota Hamfest and Computer show. The Sarasota ARC will host this event from 9 AM-5 PM. VE Exams. For general info, call Gene Marino W1DHF, (813) 355-0675. For tickets call Val Lopez KC4YAY,

(813) 951-1072; or write: Hamfest, P.O. Box 31832, Sarasota FL 34230.

JAN 30

DOVER, OH The Tusco ARC Hamfest will be held at Ohio Nat'l Guard Armory, 2800 N. Wooster Ave., starting at 8 AM. Talk-in on 146.730 W8ZX Rptr. Contact Howard Blind K10XK, 6288 Echo Lake Rd. N.E., New Philadelphia OH 44663. Tel. (216) 364-5258.

ODENTON, MD The Maryland Mobiles ARC will sponsor a Post Holiday Swapfest and Flea Market at Odenton Vol. Fire Dept. Hall, 1425 Annapolis Rd., 8 AM-2 PM. ARRL sanctioned. For VE Exams, pre-register with Jerry Gavin N3JD, 7801 Overhill Rd., Glen Burnie MD 21060; Tel. (410) 761-1423 (anytime). To register for tables, contact Tom Wilkinson KA3OMU, 592 Eason Dr., Severn MD 21144; Tel. (410) 969-2639 (eves.). Talk-in on 146.205/805.

FEB 5

ST. CATHARINES, ONTARIO, CANADA The Niagara Peninsula ARC Inc. will hold its 16th annual Big Event Hamfest at the C.A.W. Hall, 124 Bunting Rd. Write or call, N.P.A.R.C. Inc., P.O. Box 20036, Grantham Postal Outlet, St. Catharines, Ontario L2M 7W7; Tel. (905) 937-6208.

SPECIAL EVENT STATIONS

JAN 8

ST. PAUL, MN The Minnesota Frostdite Falls Beach Party, sponsored by the St. Paul RC, will be on the air from 1800Z-2400Z. Frequencies: CW - 3.540, 3.690, 7.040, 7.140, 14.040, 21.040, 28.040, 28.140; SSB - 3.850, 7.250, 14.250, 21.350, 28.350. Send logs to Ed Van Cleave AA0HL, 2700 16th St. NW, St. Paul MN 55112; Tel. (612) 636-0108. Please send SASE for info and sample log.

JAN 15

SEATTLE, WA The North West QRP Club will sponsor their Winter North-West QRP Sprint Contest 6PM-10 PM PST. Look for them on the standard QRP frequencies, 80, 40 and 20 meters. Contact Bill Todd N7MFB, North-West QRP Club, 4153 49th Ave. SW, Seattle WA 98116; Tel. (206) 937-2005 (between 5-10 PM).

JAN 17

BRAIDWOOD, IL The Kankakee Area RS will operate W9AZ from 0000Z-0600Z and 1400Z-2400Z on the lower portion of the General bands. For either a certificate or QSL card (specify) honoring Sir Thomas Crapper, send QSL and SASE to Willis Bowser, 1210 North Riverside Dr., Mokena IL 60454.

JAN 22

GALLATIN, TN The Tenn. Valley AR Network will hold their 1994 Hamfest at Volunteer State Community College, on Hwy. 31E, (between Gallatin and Hendersonville) starting at 8 AM. Packet Forum 10 AM-noon. VE Exams: pre-register with SASE before Jan. 8th to Ronnie Gilley, 512 Hillside Dr., Gallatin TN 37066. Talk-in on 147.90/30, 114.8 and 442.600+ Rptr. For general info and reservations, send SASE to Bill Ferrell, 1120 Douglas Bend Rd., Gallatin TN 37066; Tel. (615) 452-3962.

JAN 28

SAN DIEGO, CA Challenger Jr. H.S. ARC will operate K16YG between 1400Z-2400Z, to commemorate the 8th Anniversary of the Challenger Space Shuttle tragedy. Operation will be on the 20, 15 and 10 meter bands: 14.280, 21.280, and 28.380, depending on conditions. For a commemorative QSL card, send your QSL and SASE to Challenger JHS ARC, 10810 Parkdale Ave., San Diego CA 92126 or Frank Forrester K16YG at callbook address.

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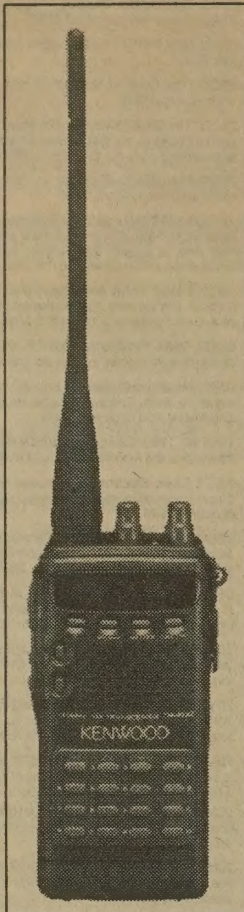
The SmartLock may be used with SG-230 Smarttuners manufactured after September 1, 1993. The SmartLock control box is priced at \$59.95. Owners of earlier versions of the Smarttuner, which do not have the additional control line, may upgrade to the latest version for \$289 (not including SmartLock). For more information contact *SGC Inc., P.O. Box 3526, Bellevue, WA, 98009; (800) 259-7331, (206) 746-6310, FAX (206) 746-6384.* Or circle Reader Service No. 207.

SGC
SGC, Inc., has unveiled its new SmartLock to further enhance the severe service capability of the SG-230 Smarttuner. The Smarttuner is a fully auto-

KENWOOD
This new series of HT transceivers from Kenwood has all of the things you want in a portable communications package. The TH-22AT (2 meter) and TH-42AT (450 MHz) single-band HTs offer a streamlined look, simple programming, one-touch controls, and easy menu functions.

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For more information, visit your local dealer or contact *Kenwood Communications Corporation, P.O. Box 22745, Long Beach, CA, 90801-5745; (310) 639-4200.*



JADE PRODUCTS

Jade Products, Inc. has announced the newest members to the FUN-KIT line: the Lead-Acid/Gel-Cel Battery Charger Kits. This series of products is based on the Unitrode UC3906 battery charger chip. This smart chip is specifically designed to sense the condition of the battery and adjust the charging requirements accordingly. The charger can be left connected indefinitely to the battery, keeping the battery ready for service at all times. This charg-

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These battery chargers are intended for hams who need to keep their batteries ready at all times. Applications include: repeater back-up batteries, QRP station batteries, and emergency equipment batteries.

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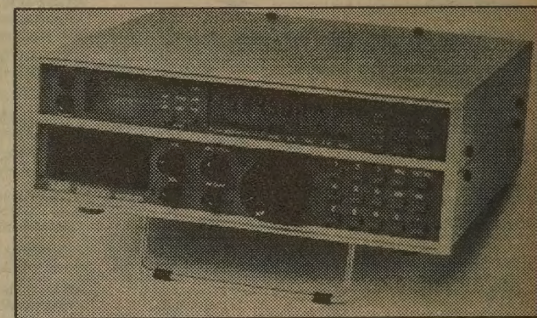
to 1 amp maximum charging rate. The price is \$79.95. The BC02 is the same as the BC01, minus the enclosure, RFI filter module, line cord, and current meter. The price is \$39.95. The BC03 is the same as the BC02, minus the power transformer. The price is \$29.95.

For further information contact *Jade Products, Inc., P.O. Box 368, E. Hampstead, NH 03826; (603) 329-6995, FAX (603) 329-4499.* Or circle Reader Service No. 201.

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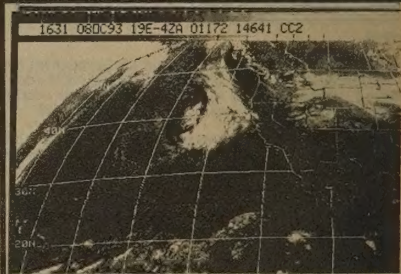
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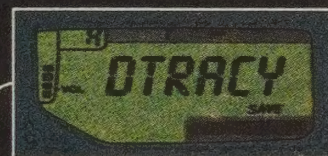
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**MORE
POWER!**



Features

- 3-watt output from MOS FET power module and supplied 6-volt battery (TH-22AT: approx. 3 watts, TH-42AT: approx. 2.5 watts), and 5-watt output with optional PB-34!
- Compact design: 2-3/16 x 4-5/8 x 1 in.
- Built-in DTMF keypad with monitor
- Built-in DTSS page system ■ Large 1-7/16" speaker
- 41 EPROM channel memories (including 1 call channel)
- Multiple scan functions (VFO, call & memory)
- Carrier-operated & time-operated scan modes
- Tone alert with elapsed time indicator
- Battery-saver circuit and auto power-off function to extend battery life ■ Selectable squelch configuration
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- User-friendly menu system to customize your operating preferences ■ Easy to program and use
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